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Animal science

ANIMAL SCIENCE

(Animal Agriculture Series)

by

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To the Memory
of my father, the late Jacob Ensminger, who
was my first instructor in animal science
and the best stockman I have ever known,
this book is dedicated.

PREFACE TO THE FIRST EDITION

Writing is my hobby. In pursuing my hobby, therefore, I have assembled and illustrated the material herein presented. Animal Science is for (1) young animal husbandmen, including 4-H and FFA members and college students, and (2) farmers and ranchers, for reference purposes. It is hoped that this book may prove interesting, understandable, and informative.

Much of the material in this book is based on my personal experiences as a 4-H club and FFA member, farmer, ranch manager, teacher, and counselor to students, stockmen, and industrialists; experiences that have been accumulated in different sections of the United States, from coast to coast. In addition to the store of factual information herein presented, I have devoted some discussion to historical events and human-interest stories. After all, the roots of the present lie deep in the past, and historical events often help to interpret the present and to project into the future. In this respect, the livestock industry is no exception.

In using *Animal Science* as a high school or college textbook, it is not necessary that the instructor should attempt to cover all of this material in any one course. Rather, through prudent selection of the assignments or chapters, this book may be equally effective for use in (1) a general introductory course in animal husbandry, or (2) the several production courses in the fields of beef cattle, sheep and goats, swine, and horses and mules. In the former case, a sound perspective or panorama of the far-flung field of animal science may be obtained; whereas, in the latter, the student may delve into more specialized material pertaining to the different classes of farm animals.

Many stockmen, including both amateurs and "old timers," have long felt a need for a practical, yet scientific, stockman's reference book. It is hoped that *Animal Science* will fulfill this need.

With the help of the many eminent livestock authorities from coast to coast, whose able assistance is gratefully acknowledged in the specific chapters that they have reviewed, the author has tried earnestly and humbly to meet the objectives outlined above. It is hoped that *Animal Science* will prove valuable for teachers and students alike, and that it will be accorded a place

of honor and active use in the home library of livestock farmers and ranchers throughout America.

I wish to make special acknowledgment of the assistance of Irvin H. Luiten, Head, Editorial Department, State College of Washington, who edited the entire manuscript; of the assistance of Everett M. Webb, Head, Agricultural Education, State College of Washington, who reviewed the entire manuscript; of the assistance of three of my colleagues in the Department of Animal Husbandry, State College of Washington— R. F. Johnson, who prepared the illustrated drawings, E. E. Goodwin, who did much of the library research, and Charles Lindley, who made the final review of the manuscript; of the assistance of Mrs. Milton Mosher, who made many helpful suggestions and in some ingenious manner deciphered the original manuscript and put it through a typewriter; and of the assistance of my wife, Audrey Helen, without whose help and encouragement the the task would not have been completed. I also wish to express my deep appreciation to all those who responded so liberally to my call for pictures.

M. E. ENSMINGER.

January 1950
Pullman, Washington

PREFACE TO THE SECOND EDITION

Since the first edition of ANIMAL SCIENCE was published only about a year ago, no major revisions are necessary at this time. A few minor changes and additions have been included in order to keep the book current. By popular request of stockmen and students, a section on "Feed Allowance And Some Suggested Rations" has been added to each of the feeding chapters pertaining to beef cattle, sheep, swine, and horses.

In order that stockmen, students, and teachers may accept and use with confidence the information and recommendations contained in ANIMAL SCIENCE, the author pledges to continue seeking, analyzing, and incorporating the latest information in the broad field of animal science.

To the end that Animal Science shall be of the greatest service and usefulness, I welcome criticisms and suggestions.

M. E. Ensminger

July, 1951
Pullman, Washington

REFERENCES

Added chapters relative to each of the specific classes of livestock on the subjects of

BUILDINGS AND EQUIPMENT

HEALTH, DISEASE PREVENTION, AND PARASITE CONTROL

SELECTING, FITTING, AND SHOWING
(Equitation in Horse Husbandry)

are presented in the following books by the same author and the same publisher as *Animal Science*:

Beef Cattle Husbandry

Sheep Husbandry

Swine Husbandry

Horse Husbandry

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CHAPTER I

THE FIELD OF ANIMAL SCIENCE[1]

Animal science refers to the total store of knowledge relative to the breeding, feeding, and care and management of animals and the marketing and processing of animals and their products, as gained through practical experience and research methods.

Animal agriculture is essential to a well-nourished and happy people. If we would look in the family refrigerator, we would find a lot of animal products—foods derived from beef and dairy cattle, pigs, sheep, and poultry. Behind the livestock, we would see vast expanses of pasture and range land, feed grains, and such by-product feeds as cull potatoes, beet by-products, and surplus citrus fruit—all being utilized as animal feeds. Back of the feeds are the soil resources, spring rains, and the energy of the sun. With calloused hands, the farmer and rancher combines these to produce a tasty platter of meat for the table, cream for the peaches, butter for the biscuit, cheese for the macaroni, and lightness for the cake—and all are derived from the land via animals. In addition, leather, fats, wool, grease for soap, glands for adrenalin and other essential medical products, glues, gelatins, important organic chemicals, and countless other materials come from animals raised on American farms and ranches. But back of present-day successful animal production has gone years of experience and scientific research—progress in animal breeding; feeding; physiology; disease and parasite control; manage-

[1]The author gratefully acknowledges the helpful suggestions of the following eminent authorities who reviewed Chapter I: Dean H. P. Rusk, College of Agriculture, University of Illinois, Urbana, Illinois; Dr. Roscoe R. Snapp, Department of Animal Husbandry, University of Illinois, Urbana, Illinois; Dr. K. L. Turk, Head, Department of Animal Husbandry, Cornell University, Ithaca, New York; Dr. E. J. Warwick, Geneticist, Bureau of Animal Industry U.S.D.A., and Professor of Animal Husbandry, University of Tennessee, Knoxville, Tennessee, Dr. Gustav Bohstedt, Head, Department of Animal Husbandry, University of Wisconsin, Madison, Wisconsin; Professor L. A. Weaver, Head, Department of Animal Husbandry, University of Missouri, Columbia, Missouri; Dr. S. S. Wheeler, Head, Department of Animal and Dairy Industry, Colorado Agricultural and Mechanical College, Fort Collins, Colorado; Mr. J. L. Schwendiman, Soil Conservation Service, U.S.D.A., Pullman, Washington; and Mr. Charles E. Snyder, Editor, Chicago Daily Drovers' Journal, Union Stock Yards, Chicago, Illinois. Mr. Snyder also kindly reviewed Chapters II through VII.

ment; marketing; and processing, storing and distribution of meat, milk, and eggs. This progress is the result of studies and experiences that have extended from the farms and ranches to the nation's kitchens.

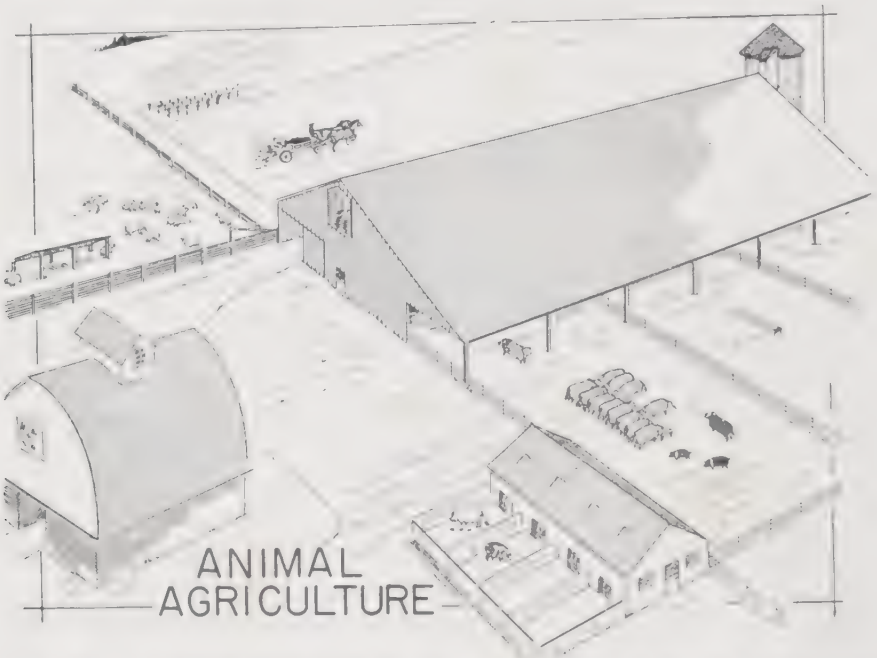


Fig. 1. Drawing portraying animal agriculture. An animal agriculture is essential to a well-nourished and happy people. (Drawing by R. F. Johnson.)

THE BIRTH OF ANIMAL SCIENCE

The field of animal science had its humble beginning with the domestication of animals, for from this remote day forward it was necessary to give attention to their breeding, feeding, and care and management.

The domestication of animals also marked the first step toward the civilization of the most primitive tribes of men—the transformation from the savage to the civilized way of life. Savage man hunted animals as sources of food and raiment. He lived on what roots, berries, and seeds he could find and on such insects, animals, and fish as he could catch. In addition, he was only too likely to include his fellow man in his hunting and eating.

From very early times, man had domesticated the dog, using him to assist in his hunting and to provide protection by night. Perhaps even more important, the presence of the dog furnished

animal companionship, thus filling a deep-rooted want which has always existed in human beings.

Gradually, man adopted a more settled mode of life, and with this came the desire to safeguard the food supply for times when hunting was poor and to have the food close at hand. At this stage, seeds were planted near the camp site; roots and grains were stored for winter use; and nearly all of our modern animals were tamed and confined or, as we say, domesticated.



Fig. 2. Ancient drawing of a bison on a rock, made by Paleolithic (Old Stone Age) man. Even prior to their domestication, man revered animals, according them a conspicuous place in the art of the day. (Courtesy, The Bettmann Archive.)

In addition to using domestic animals as a more certain supply of food and clothing, ingenious man soon began to use them for purposes of pack and draft. Also, through selection and controlled matings, he molded animal types better to serve specific needs.

But the contribution of animals extended far beyond their utility value. Man revered animals, giving them a conspicuous place in the art of the day and making them the chief object of worship and myth and the sacrificial offering of many a religious ceremony. From the day of domestication forward, the herding of animals became indicative of the superiority of one tribe over another, and always the great livestock countries of the world

have supported the most advanced civilizations and have been the most powerful. Down through the ages, therefore, animals have been man's most useful helpmates—contributing richly to his food, clothing, power, recreation, and inspiration.

DISTRIBUTION OF ANIMALS AND EARLY AMERICAN IMPORTATIONS

Man appeared to follow the migration of animals prior to their domestication in order to keep near his food supply. But with the taming and confinement of animals, man took the initiative in migrating and moved animals with him. It was in this very manner that domestic animals were brought to the Western



Fig. 3. Neolithic (New Stone Age) man continued to hunt animals as a source of food and raiment, even though at this remote period many animals had been domesticated. (Photo from a painting by Chas. Knight, obtained through the courtesy of the American Museum of Natural History, New York.)

Hemisphere; for only the llama, alpaca, guinea pig, and turkey were native to the Americas at the time of Columbus' first landing in 1492. Yet, today, the United States possesses the largest and most varied domestic animal population of all countries.

It is generally believed that cattle, pigs, sheep, goats, and horses were first brought to the West Indies by Christopher Columbus on his second voyage in 1493. Cattle, horses, and sheep were brought to Mexico by Cortez in 1519; whereas pigs and horses were first introduced directly into what is now the United States by Hernando DeSoto in 1539.

TRANSFORMATION OF THE UNITED STATES LIVESTOCK INDUSTRY

The domestic animals that were first brought to America by the Spanish explorers were of low efficiency in comparison with those of present standards. Nevertheless, they furnished the sturdy foundation stock that was subsequently improved and developed into a great industry.

As cities grew and animals increased in numbers and pushed inland from the eastern seaboard, there was the development of trailing and marketing, the enlargement of the local slaughter



Fig. 4. Photograph of the painting, *The Sacrifice of Noah*, by Bernardo Cavallino. This shows an animal being served up as an offering to the deities. In the early-day, the contribution of animals extended far beyond their utility value—they were the chief object of worship and myth and the sacrificial offering for many a religious ceremony. (Courtesy, National Gallery of Art, Kress Collection.)

house, and eventually the birth of the modern packing industry. Following closely in period of time came the development of railroads, the luxury of rail transportation of animals, and the perfection of artificial refrigeration and the refrigerator car. Such developments marked a new era in animal production. In the meantime, there was the opening of the fertile Ohio Valley and the western range.

With this rapid development and expansion of the livestock industry came the demand for improvement in breeding. Progressive breeders, ever awake to their opportunity, proceeded to make large importations of animals from the mother countries—especially from Great Britain, France, and Spain. Thus, through the years, the Texas Longhorns were replaced by the prime bullock; the Arkansas Razorbacks were replaced by improved meat-



Fig. 5. George Washington at Mount Vernon. The first president possessed a keen interest in animals and contributed immeasurably to their improvement. (From a Courier and Ives Lithograph, obtained through the courtesy of The Bettmann Archive.)

type swine; and the black, brown, and spotted sheep were replaced by modern mutton and wool-type animals. Hand in hand with improved breeding came improved feeding and management.

United States Animal and Human Population Trends

Despite all the improvements that have been wrought in the husbandry of animals and in the marketing, processing, and distribution of animals and their products, United States animal numbers have failed to keep pace with human population increases. Table 1 gives the comparative United States animal and human populations in 1840 and 1948, whereas Figure 6

shows their respective population trends during this same period of time.[1]

TABLE 1

UNITED STATES ANIMAL AND HUMAN POPULATION IN 1840 AND 1948[1]

Human or animal population	1840 or as designated		1948 or as designated
Human population	17,069,000		145,000,000
All cattle	14,971,000		78,564,000
Milk cows (cows & heifers 2 years old or over kept for milk)	1850 6,385,000		25,165,000
Swine	26,301,000		55,038,000[1]
Sheep	19,311,000		35,332,000
Poultry (chicken and turkeys)	1880 102,272,000	1947	479,655,000
Horses and mules	4,336,000		9,151,000

[1]Includes only spring farrowed pigs.

On January 1, 1948, for every hundred people in this country, there were 54 cattle and calves, compared with a peak of 97 in 1888; 24 sheep and lambs, compared with 124 in the peak year of 1867; and 38 hogs, compared with an all-time high of 94 in 1872. But animal numbers alone do not tell the whole story. Productivity per animal unit has been greatly accelerated. Meat animals now mature more rapidly than formerly—the quicker turnover actually meaning more products from a fewer number of animals. Dairy cattle and poultry also produce more milk and eggs, respectively. Also, meat exports have steadily declined from a total of 1,972 million pounds (beef, pork, and lard) exported in 1900 to only 312 million pounds exported in 1940. Despite a tremendous human population increase with a much smaller change in meat animal numbers, per capita meat con-

[1]Source: Compiled from figures in several U. S. Department of Agriculture publications and Census Reports. Figures for all cattle, milk cows, swine, sheep, and horses and mules for period 1840 to 1890 obtained from *Sixteenth Census*; for 1891 to 1899 and 1921 to 1929 from *Livestock, Meats, and Wool Market Statistics and Related Data*, U. S. Dept. of Agri., 1935, p. 6; for 1900 to 1920 from *Livestock, Meats and Wool Market Statistics and Related Data*, U. S. Dept. of Agri., 1942; for 1930 through 1946 from *Agricultural Statistics*, U. S. Dept. of Agri., 1948, p. 369; and from 1947 and 1948 data, p. 4. Poultry data up through 1944 obtained from *Census of Agriculture*, 1945, p. 342, and for 1947 from *Agricultural Statistics*, U. S. Dept. of Agri., 1948, pp. 406 and 424. Human population obtained from *Sixteenth Census of the United States*, except that 1948 figure is an estimate.

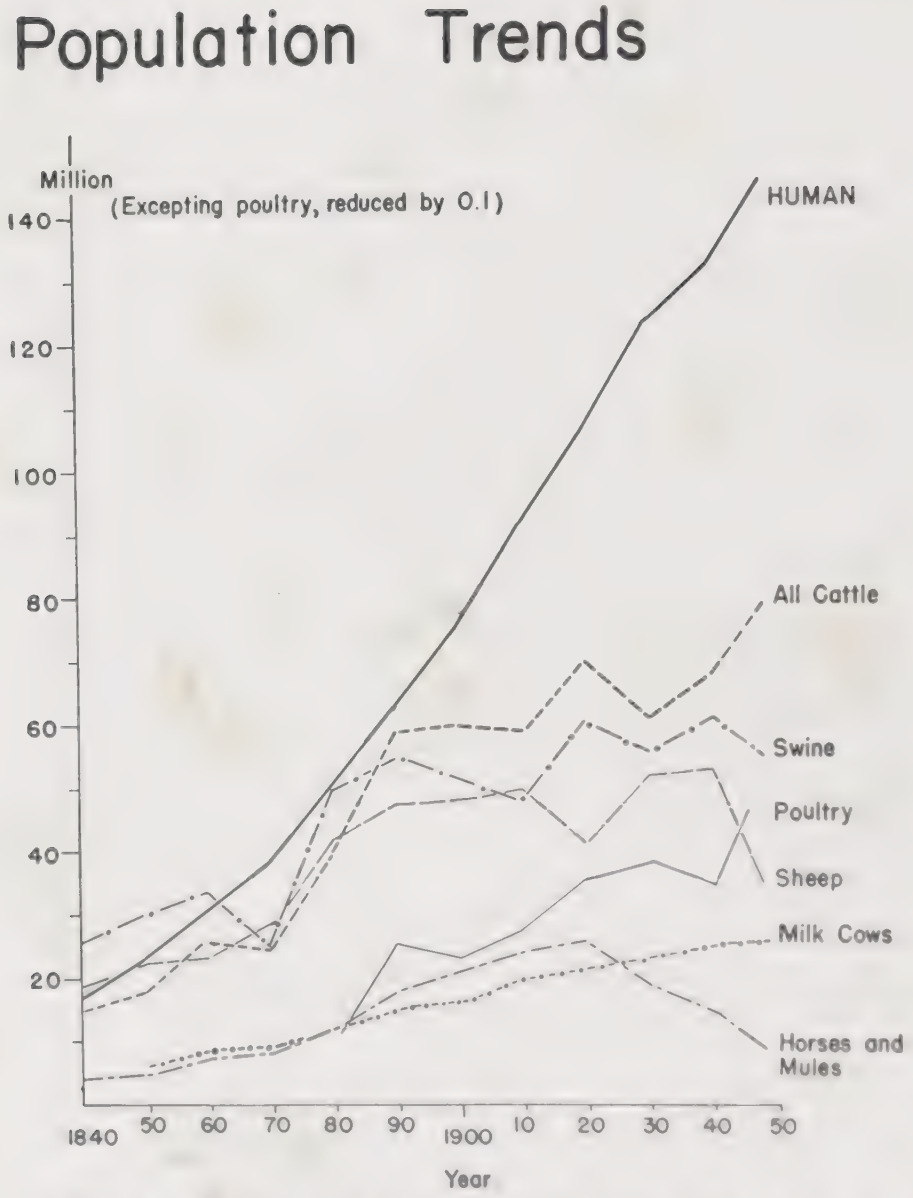


Fig. 6. U. S. animal and human population trends. Note that animal numbers have failed to keep pace with human population increases. (Prepared from Census and U. S. Department of Agriculture data.)

sumption in this country has changed very little. For example, the 1905 per capita meat consumption totaled 154.4 pounds, whereas in 1947 it was 155.2 pounds.

Further human population increases are inevitable, but no such comparable expansion in livestock numbers can be supported in the United States for two primary reasons. First, few new land areas can be brought into production; and second, it is necessary that caution be taken in order to avoid overstocking during periods of drought or crop failure.

Expressed in terms of animal units (one mature horse or cow or the equivalent), the United States yearly animal unit totals during the past fifty years have fluctuated between 74 million and 91 million, with an average of about 81 million.

Perhaps in the future some additional quantities of meats may be imported for the purpose of maintaining a high per capita meat consumption for the expanding human population. More important, however—inefficient animals must be eliminated. This elimination is inevitable if this nation is to have a long-range meat program that will supply the nutritional requirements of an expanding population on a basis which will be profitable to producers.

Animal Products versus a Cereal Grain Diet

Historically, the people of new and sparsely populated countries have been meat eaters, whereas the people of the older and more densely populated areas have been vegetarians. The latter group has been forced to eliminate considerable animals and to consume plants and grains directly in an effort to avoid famine. Unless the people of America either greatly increase the efficiency of animal production or step up meat imports, it is quite likely that we shall gradually lower the per capita meat consumption.

Forgetting for a moment the high nutritive values of meats, there can be no question that more hunger can be alleviated with a given quantity of grain by completely eliminating animals. When fed grains alone, about twelve to fifteen pounds of concentrates must be supplied to livestock in order to produce enough meat and other livestock products to support a man for one day, whereas two or three pounds of grain (corn, wheat, rice, soybeans, etc.) eaten directly will support a man for a day. Thus a given quantity of grain eaten directly will feed five to six times more people than it will if it is first fed to livestock and then is

eaten indirectly by humans in the form of livestock products. This is caused by the unavoidable nutrient losses in all animal feeding and the fact that no return is received from that portion of the animal's feed which goes for maintenance (which amounts to approximately one-half). This is precisely the reason why the people of the Orient have been forced into becoming vegetarians.

Yet the people of this country will never voluntarily submit to this Oriental way of life. It would not be making the most efficient use of our American resources, particularly the pasture and range areas and inedible concentrates and by-products. Then there is the added problem of erosion control and fertility maintenance which can best be accomplished through livestock farming or ranching. The inclusion of animal products in the diet also makes for greater palatability and ease in providing the necessary nutrients—especially quality proteins, minerals, and vitamins. The latter is important, for a person may be receiving all that he needs in the way of calories and yet be undernourished. For this reason, meat, milk, and eggs are often referred to as protective foods.

Finally, the presence of animals makes for an ever-normal refrigerator rather than an ever-normal granary. When feeds are abundant, animals may be fed more liberally and longer; whereas, when feeds are scarce, more animals can be slaughtered, and they can be slaughtered at lighter weights and with less finish. Where people rely chiefly on a cereal grain diet rather than on animal products—as in the Orient where famines so often stalk across the land—no such flexibility exists.

MAGNITUDE OF THE UNITED STATES LIVESTOCK INDUSTRY

The far-flung livestock business comprises one of the largest industries in the United States. Providing America's meat requires the day-to-day energies of five million farmers and ranchers, approximately four thousand meat packers and other commercial slaughterers, and three hundred and fifty thousand retail meat dealers who employ about a million persons. It requires immense investments in farms and ranches, herds, processing plants, and vast networks of transportation lines and distribution facilities. In the sections that follow, the magnitude of the livestock industry will be shown through several important criteria.

Land Area and Number of Farms and Ranches Devoted to Animal Production

Animals are the largest users of the nation's land. Figure 7 shows land use and land ownership of the total land area of the United States. Table 2 presents this same data and additional data relative to the number of farms and ranches in the United States.

Although land use is not constant, it is noteworthy that two-thirds (66.7 per cent) of the total land area of the United States is devoted to the production of animal feeds, including

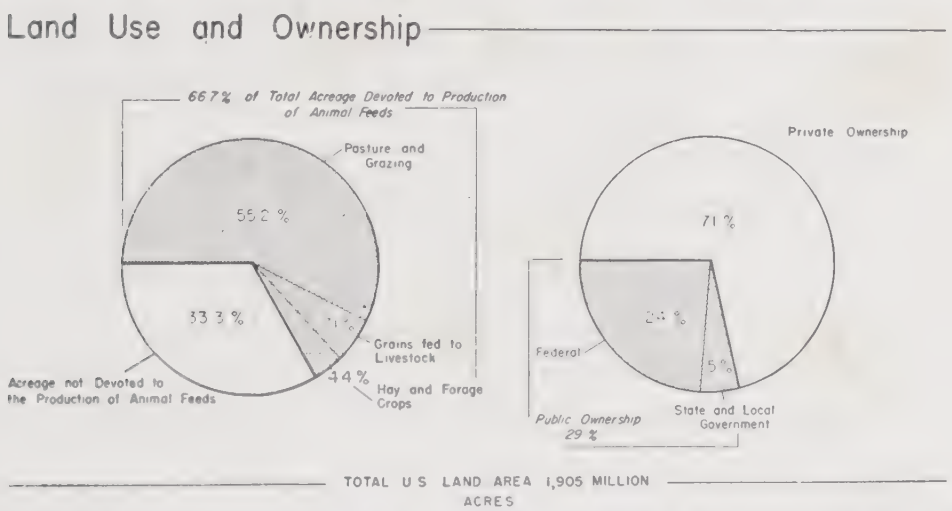


Fig. 7. Land use (left) and ownership (right) of the total land area of the United States. It is noteworthy (1) that 66.7 per cent of the total United States land area is devoted to the production of animal feeds; and (2) that 29.0 per cent of the total United States land area is under public ownership. (Data obtained from U.S.D.A., and based on Table 2; drawing by R. F. Johnson.)

55.2 per cent of the United States lands used for grazing purposes and an additional 11.5 per cent devoted to the production of hay and other forage crops and grain. Both publicly and privately owned lands are used in the production of animal feeds.

Most United States lands are privately owned, but an astounding 552 million acres, or 29 per cent of all United States lands, are under public ownership. The Federal Government, with 458 million acres, or 24 per cent of all United States lands, controls most of the publicly owned lands. State and local governments own an additional 94 million acres. The publicly owned lands are, for the most part, effectively used by private farmers and ranchers for livestock production under a grazing permit system. It is unfortunate, however, that nearly 90 per cent of the

TABLE 2

LAND USE, LAND OWNERSHIP, AND NUMBER OF FARMS AND RANCHES IN THE UNITED STATES[1]

		Acreage (million acres)	Percentage of total (per cent)
Total land area of the United States		1,905	100.0
I Land use	A. Acreage devoted to production of animal feeds	1,272	66.7
	1. Pasture and grazing land	1,052	55.2
	2. Hay and other forage crops	85	4.4
	3. Grains fed extensively to livestock (corn, oats, and barley)	135	7.1
	B. Acreage not devoted to production of animal feeds (including forests not pastured, cities and towns, roadways, farmsteads, crop failure and fallow areas, etc.)	633	33.3
II Ownership	A. Private ownership	1,353	71.0
	B. Public ownership	552	29.0
	1. Federal	458	24.0
	2. State and local governments	94	5.0
III In farms and ranches	A. Land in nation's 5,379,043 farms and ranches	1,142	59.9
	B. Land not in farms and ranches	763	40.1

[1]Most figures obtained from U. S. Dept. of Agri. sources, including *Federal Rural Lands*, June, 1947; and Inventory of *Major Land Uses in the United States*, Misc. Pub. 663. Number of farms and ranches from preliminary figures, 1950 census of agriculture.

federal holdings are located in the eleven western livestock states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Fifty-four per cent of the total land area in these eleven public land states is controlled by the Federal Government; whereas, by contrast, in the state of New York, only nine-tenths of one per cent of the land is federally controlled. Naturally, the character of the land

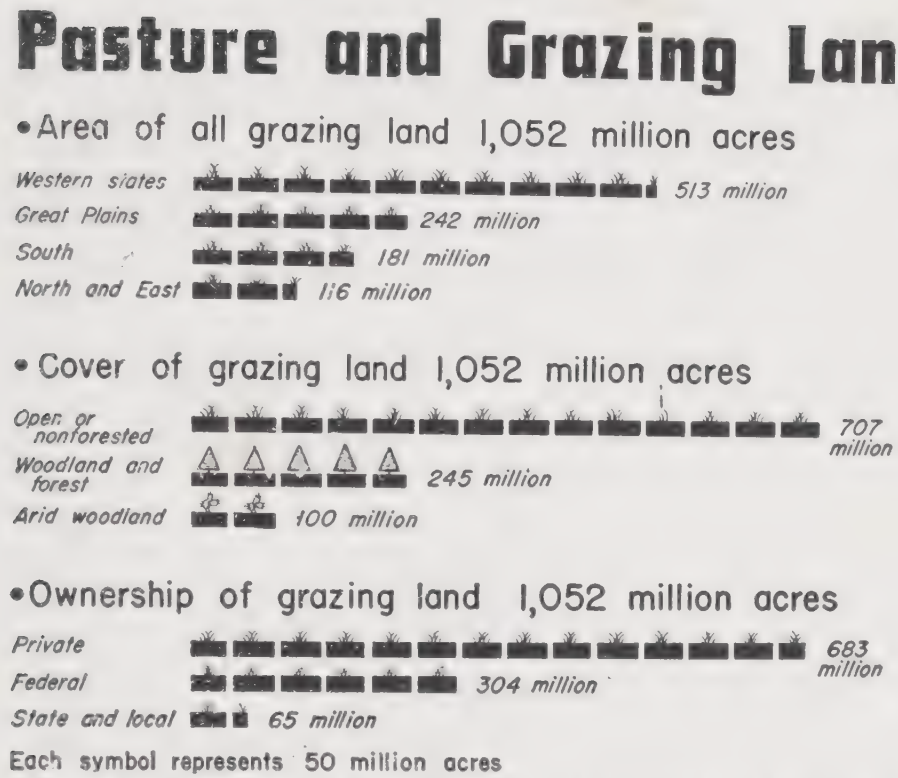


Fig. 8. Location, type of cover, and kind of ownership of the 1,052 million acres devoted to pasture and grazing land in the United States. (Most of data obtained from U.S.D.A. sources; drawing by R. F. Johnson.)

area rather than state boundaries has been the chief criterion in arriving at what lands shall remain under Federal ownership.

Table 2 also brings out the fact that 59.9 per cent of the total land area of the United States is operated in the nation's 5,379,043 farms and ranches. According to the census of 1940, almost 5 million farm and ranch units had some cattle, nearly 4 million had hogs, and almost 600,000 had sheep.[1] The remaining 40.1 per cent of nonfarm and ranch area consists chiefly of publicly owned lands, cities and towns, and areas not suitable or available for private operation, but much of this area is grazed by animals.

Since pasture and grazing lands are primarily devoted to livestock production, it is important that the stockman be informed as to location, type of cover, and the kind of ownership of the 1,052 million acres devoted to pasture and grazing land in the United States. Figure 8 presents this information. As shown, the two areas known as the Western States and the Great Plains, respectively, are the largest and most important grazing

[1] In 1940, there were 5,859,169 U. S. farms and ranches.

territories in the nation. It is to be noted that of the 1,052 million acres of pasture land, about 707 million acres are open pasture and 245 million acres woodland and forest pasture. Approximately 683 million acres, or only two-thirds of the 1,052 million acres of pasture and grazing lands, is privately owned. Of the remaining 369 million acres, about 304 million acres are federally owned, with 65 million acres belonging to states and local governments.

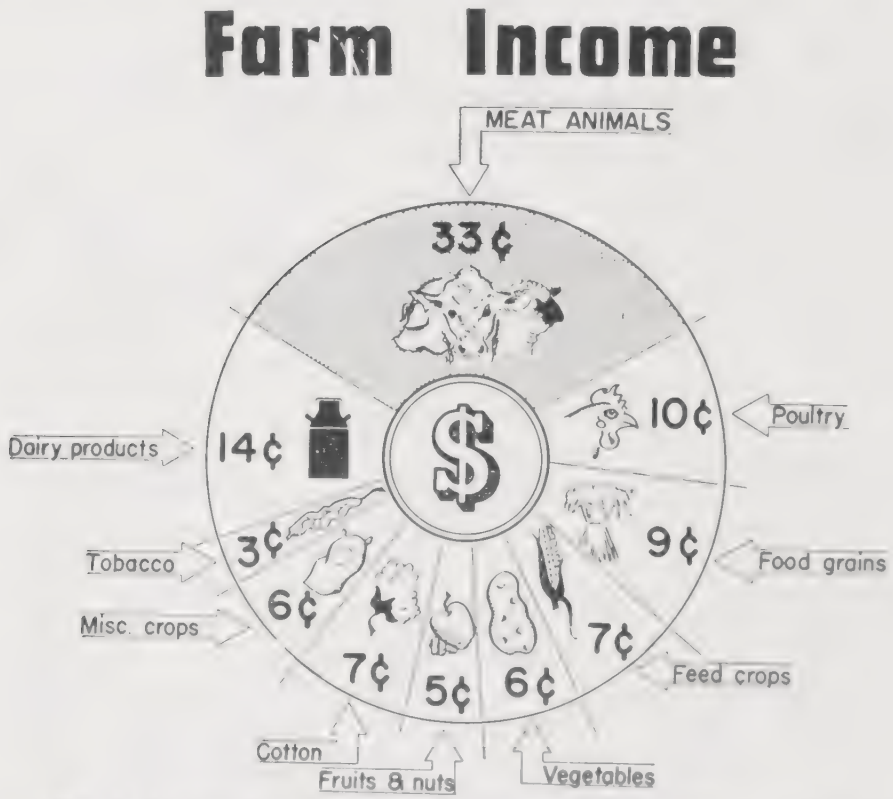


Fig. 9. Comparative cash income derived from different agricultural pursuits, 1947. It is noteworthy that about a third of the American farmer's cash income came from the sale of meat animals alone. (Data obtained from U.S.D.A., through the courtesy of the American Meat Institute; drawing by R. F. Johnson.)

Comparative Cash Income Derived From Different Agricultural Pursuits

The eight leading sources of farm and ranch income in the United States for the sixteen-year period, from 1225 through 1940 and for the year 1947 alone were as shown in Table 3.[1]

[1]From Reference Book of the Industry, compiled from U. S. Dept. of Agri. data; and diagram compiled by the American Meat Institute in 1947.

TABLE 3

COMPARATIVE CASH INCOME DERIVED FROM DIFFERENT AGRICULTURAL PURSUITS; (A) AVERAGE 1925-40 AND (B) 1947 ALONE

Leading sources of farm and ranch income, by rank	Average per cent cash income derived from sources indicated, 1925 to 1940	Per cent cash income derived from sources indicated, 1947 alone
Meat animals	26.9	33.0
Dairy products	17.3	14.0
Grains	11.9	16.0[1]
Cotton; cotton seed	11.4	7.0
Poultry and eggs	9.7	10.0
Vegetables	7.4	6.0
Fruits and nuts	5.5	5.0
Tobacco	2.8	3.0
Other sources	7.1	6.0
TOTAL	100.0	100.0

[1]Of the total of 16 per cent derived from grains, 7 per cent was from feed crops (corn, oats, barley, etc.) and 9 per cent from food grains (wheat, rye, rice, buckwheat, etc.).

It is noteworthy that during the sixteen-year period, 1925 to 1940, livestock (meat animals, dairy products, poultry, and eggs) accounted for an average of 53.9 per cent of the cash income derived by the United States farmers and ranchers, with the sale of livestock for meat purposes exceeding any other single source. Thus, of each $100.00 worth of products sold, animals and their products accounted for $53.90; whereas grains, cotton, vegetables, fruit and nuts, tobacco, etc., brought in $46.10.

As would be expected, the proportions are somewhat changeable from year to year, depending upon the relative value of the various farm products and the amount produced. Thus, in 1947, animal products were in an even stronger position, accounting for 57 per cent of the farm and ranch income. In addition to the cash income aspects, it is important to remember that the available home supply of animal products greatly improves the diets of farm people. Figure 9, which presents the comparative cash income derived from different agricultural pursuits for the year 1947, shows that in that year about a third of the American farmer's cash income came from the sale of meat animals alone.

Number and Value of Livestock on Farms and Ranches

Table 4 gives the numbers and total value of livestock on United States farms and ranches, by classes, in 1948. As will be

TABLE 4

NUMBERS AND VALUE (TOTAL VALUE AND VALUE/HEAD) OF LIVESTOCK ON UNITED STATES FARMS, BY CLASSES, JANUARY 1, 1948[1]

Class	Number	Farm Value	
		Value	Total value
	(Thousands)	(Dollars/head)	(Thousands)
All cattle	78,126	$116.00	$ 9,094,334
Cattle other than milk cows	53,087	94.00	4,991,366
Hogs	55,028	42.80	2,356,160
Sheep	34,827	15.40	534,679
Goats and kids (1945)[2]	4,266	4.03	17,200
Horses	6,589	55.50	365,802
Mules	2,541	133.00	337,409
Sub-totals of farm animals (deleting cattle other than milk cows)	177,111		12,705,584[3]
Chicken	461,550	1.44	665,227
Turkeys	4,450	6.87	30,590
Grand totals (farm animals plus poultry)	643,111		13,401,401

[1] *Agricultural Statistics*, U. S. Dept. of Agri., 1949, pp. 343, 363, 375, 405, 445, and 465.

[2] U. S. Bureau of the Census, United States Census of Agriculture, II, (Washington Government Printing Office, 1945), p. 400.

[3] Not including cattle other than milk cows which are already a part of the figure of "all cattle."

noted, there were more than 177 million head of farm animals with an aggregate value of more than 12 billion dollars. In addition, there were 166 million turkeys and chickens, and the total value of farm animals and poultry exceeded 13 billion dollars. Thus animals represent a huge investment on the part of farmers and ranchers.

Size of the Meat Packing Industry

In total value of products produced the meat packing industry ranks as one of the big three[1]—so ranking along with the automobile and steel industries. It also regularly provides about one-fourth of the nation's manufactured food products and employs 300,000 workers, or nearly one-sixth of the wage earners

[1] Based on a 1939 report of the American Meat Institute.

engaged in manufacturing foods and kindred products. Meat packing, therefore, is one of the nation's leading industries.

Other Organizations Engaged in the Livestock Industry

In addition to the millions of people and the many facilities engaged in raising livestock and in slaughtering, processing, and distributing the products therefrom, additional personnel and facilities are equally essential in the operation of the far-flung livestock industry. This includes such essential operations as (1) transportation and communication; (2) marketing; (3) commercial feed companies; (4) breed magazines; (5) pure-bred registry associations; and (6) research, teaching, extension, promotional, and regulatory organizations and officials.

THE FUNCTIONS OF ANIMALS

The average person is aware, at least in part, of the basic utility functions of animals in contributing food, clothing, power, and recreation. Few recognize, however, that—because of their added functions—animals are an integral part of a sound, mature, and permanent agriculture.



Fig. 10. Animals contribute food. Today, nearly half of the total food supply of man is contributed by mammalian, avian, and aquatic life. Picture shows shoulder lamb chops. (Courtesy, American Meat Institute.)

Animals Contribute Food, Clothing, Power, and Recreation

The primary utility function of animals is the production of food, clothing, power, and recreation—products upon which man became more and more dependent with each succeeding step in his advancing civilization.

Food.—The development of railroads, the perfection of artificial refrigeration, the growth of livestock markets and packing houses, the improvement and extension of highways, and the invention of the motor truck, all richly enhanced the food supply, especially the quality and quantity of available animal products. Today, nearly half of the total food supply of man is contributed by mammalian, avian, and aquatic life. The list of food products of animal origin includes meat from domestic and wild animals, fowl and eggs from domestic and wild birds, fish of many kinds, and milk from cows, mares, goats, and sheep. Research has given positive proof of the leadership of these animal foods as rich sources of those nutrients that are so essential for good health and proper nutrition.

In general, the consumption of food products of animal origin is limited by their cost, which in turn is governed by supply and demand. Naturally, the comparative prices of other food products and competition is also a major factor. Figure 112 in chapter VII shows the trends in per capita consumption of

TABLE 5

ANNUAL UNITED STATES PER CAPITA CONSUMPTION OF FOOD PRODUCTS OF ANIMAL ORIGIN, 1947[1]

Kind of animal food product	Pounds
Pork, excluding lard	69.8
Beef	69.1
Veal	10.7
Lamb and mutton	5.4
Lard	13.1
Milk, cream, and cheese (expressed as pounds of milk)	791.0
Butter	11.2
Chickens	23.6
Turkeys	4.5
Eggs, in dozens	31.0
Fish (edible weight)	10.8[2]

[1] *Agricultural Statistics*, U. S. Dept. of Agri., 1949, pp. 402, 438, 464, and 472.

[2] *Statistical Abstract of the United States*, U. S. Dept. of Commerce, 1949, p. 90.

foods by groups, with animal products listed under the categories of: (1) dairy products; (2) eggs; and (3) meats, poultry, and fish. Table 5 shows the United States per capita consumption of food products of animal origin.

Although the United States per capita consumption of animal products is higher than in most countries, without doubt, for a considerable number of people, it is still far below the nutritional optimum. For example, the daily dairy products consumption of each man, woman, and child in the United States merely averages one and one-half glasses of milk, three-



Fig. 11. Animals contribute clothing in the forms of wool, leather, hair, and furs. Picture shows a wool dress. (Courtesy, The Wool Bureau, Inc.)

fourths ounce of butter (three pats), one-fourth ounce of cheese, plus one dish of ice cream per week. Moreover, except for the cost factor, most people could—with benefit from a health standpoint—consume more meat and eggs than they are now getting. It is believed that a per capita meat consumption of somewhere between 175 and 180 pounds would be desirable from a nutritional standpoint.

Clothing.—Today, the chief contributions of animal life to clothing for man are in the forms of wool, leather, hair, and furs. In addition to serving as sources of clothing, each of these articles has many additional uses. For example, leather not only provides boots and shoes, jackets and helmets, gloves and mittens, and belts; but it is used in the manufacture of harness, belting, scabbards, holsters, gaskets, and countless other articles.

Power.—In the United States, we commonly think of horses and mules as the only sources of animal power, but in the more isolated sections of this country oxen are so used. Also, in different parts of the world and at different times, buffalo, reindeer, elephants, camels, goats, and dogs have all been brought under man's submission and used as sources of power for different purposes.



Fig. 12. Animals contribute power. However, with the invention and extension of mechanical power, there has been a steady but marked decline in this function of animals. Picture shows big-team hitches drawing combines in the famous Palouse wheat area of eastern Washington prior to the advent of tractor power. (Photo by Hutchison.)

With the invention and extension of mechanical power during the nineteenth and twentieth centuries, there has been a steady but marked decline in the use of animals as a source of power. Thus the use of horses and mules in the United States has decreased—the use of horses reaching a peak in numbers in 1915 and that of mules reaching a peak in 1925.

Recreation.—Throughout the ages, animal life has contributed to recreation and sport. It is reasonable to surmise that a certain amount of enjoyment must have accompanied primitive man's hunting and fishing, though in times of scarcity it was a



Fig. 13. Animals contribute to recreation and sport. Picture of Desert Caballeros making their annual trail ride near Castle Hot Springs, Arizona. (Courtesy, Horse Association of America.)

grim business. Today, wild animals and aquatic life contribute richly to man's enjoyment. Domestic animals, notably the horse and the dog, are used extensively in recreation and sport. Also, the animals in the zoo and the circus are a source of recreation for old and young alike. In recent years, many men of wealth have established outstanding purebred herds and flocks as a means of recreation and enjoyment. In brief, no mechanical device made by man has had such wide appeal as animals, for they serve as sources of recreation to people of all walks of life.

Animals Convert Inedible Feeds Into Valuable Products

About two-thirds of the feed used by livestock is not suited for human consumption. In this category are hay, pasture, coarse forages (such as straws, fodders, etc.); certain grains; such by-products as are obtained from mills, packing houses, etc.; and damaged grains and foods and garbage. These all are converted into meat, eggs, milk and wool.

Such well-known grains as corn, oats, and barley would have only limited value if restricted solely to direct human consumption, but because they can eventually ride to market as animal products, their value is immensely greater. A distinction needs to be made, therefore, between food grains for people and feed grains for livestock. It is also well to remember that beef cattle and sheep have always existed largely on forage, it being estimated that 80 and 95 per cent, respectively, of their total feed is derived from roughage.

Much of the forage utilized in livestock production is produced on land not suited for the raising of bread grains or gardens. Then, too, in addition to the character of the land itself, labor, tools, storage, processing plants, and transportation facilities would be limiting factors in any rapid shift away from utilizing the present inedible feeds by animals.

Animals Serve as the Sheet Anchor in Erosion Control

The spirit of adventure and the desire for freedom caused brave men to enter this country—a country characterized by a deep and fertile soil that supported great forests and broad prairies inhabited only by the Indians and the wild game which they hunted. That same gainful and aggressive spirit caused the pioneer to walk behind the plow for the breaking of the plains and to swing the axe for the cutting of the virgin forest. Within a short time, these fertile areas were to become known as the dairy and industrial area of the East; the Corn Belt of the central United States; the Cotton Belt of the South; and the wheat, alfalfa, fruit, and range country of the West—all supporting a prosperous and contented population.

Although these same fields of these United States have been in cultivation little more than 250 years—for the most part less than 100 years—many of them have already reached a stage of low productivity. Dr. H. H. Bennett, Chief of the Soil Conservation Service of the U. S. Department of Agriculture, makes the statement that: "Until recently, we Americans were impoverish-

ing and wasting our agricultural lands probably faster than any other nation or race, civilized or barbaric, in all the history of the world. Other parts of the world have been devastated by this wasteful process, and the people have deserted the skeletonized areas; but these lands were used for thousands of years."

"Now we are reversing the erosion situation through our national soil conservation program, which in the course of 15 years has brought the United States into world leadership in this field."



Fig. 14. Animals serve as the sheet anchor in erosion control. Picture shows a seriously eroded condition as the result of careless land use. The increased use of forage crops, especially grasses and legumes, offers the most logical approach to a sound program of soil and moisture conservation. (Courtesy, U.S.D.A.)

The increased use of forage crops, especially grasses and legumes, appears to be the most logical basis for a sound program of soil and moisture conservation. These sod-forming crops "nail the soil in place," preventing both wind and water erosion. Moreover, if properly utilized in livestock production, these forage crops afford adequate remuneration through adding to the weight of stock and returning valuable organic matter and nutrients to the soil.

Every citizen of the United States should come to realize that the land, regardless of ownership, is only a gift made by

nature and a gift that should be passed on to posterity. Man depends upon the topsoil for the production of food, clothing, and shelter.

Animals Maintain Soil Fertility

It should also be pointed out that cash crops, if removed from the farm, whether they be grains or forages, result in the marketing of soil fertility. Although it is possible to use green-manure crops from the standpoint of the retention of soil fertility, it is usually more practical to attain this end through feeding the grains and forages to animals. On the average general farm, with various classes and ages of animals, probably 80 per cent of the fertilizing value of the feed is excreted in the feces and urine. With proper conservation, therefore, this fertility value may be returned to the soil.

Laboratory analyses reveal that a ton of average farm manure contains the equivalent of 50 pounds of nitrate of soda, 22 pounds of 20-per-cent superphosphate, and 18 pounds of 50-per-cent muriate of potash. It must be remembered, however, that much of the fertilizing value is lost if the manure is not handled properly. Thus, when piled in an unpaved yard and left exposed to the sun, wind, and rain, manure will lose about half of its nitrogen and potash content. Where animals are running in the field, most of the fertilizing value of the manure is conserved. Though manure is more difficult to handle and more expensive under barn or feed-lot conditions, most of its fertilizing value can be saved by using plenty of bedding to absorb liquids and by storing the manure in a water-tight, weather-protected pit. Since most of the nitrogen value is in the liquids, some farmers provide a cistern and pump outside one end of the pit to handle the liquid manure.

By carefully saving all of the manure produced in livestock farming, the soil may be enriched and crop yields increased.

Animals Serve as an Important Companion of Grain Production

Livestock feeding provides a large and flexible outlet for the year-to-year changes in grain supplies. When there is a large production of grain, more can be fed to livestock, with the animals carried to heavier weights and higher finish. On the other hand, when grain supplies are low, herds and flocks can be maintained by reducing the grain that is fed and by increasing the

grasses and roughages. Thus livestock give stability to grain farming.

Animals Make for Desirable Diversification

Diversification refers to having more than one type of enterprise or source of income. There can be diversification within a specialty. For example, the poultryman might produce and market table eggs, day-old chicks, broilers, capons, etc. In general, however, the most successful diversified livestock programs have two or more classes of stock and produce a considerable portion of the feed.

In contrast to "one crop" farming, as applied to either plants or animals, a well-diversified livestock program has the following advantages:

1. It distributes the risks.
2. It establishes a more desirable basis for credit.
3. It makes for better distribution of labor—providing employment throughout the year.
4. It attracts the genuine interest of a greater number of people (family enterprise) and builds lasting character.
5. It provides for more effective utilization of home-grown feeds.
6. It makes for a more flexible farm program.
7. It allows for the development of superior markets.
8. It helps to guarantee a farm food supply of greater variety at a reasonable cost.
9. It affords an opportunity for the application of wider experience and superior managerial ability.

Without attempting to elaborate upon each point, it should be readily apparent that a well-managed diversified livestock program makes for a sound and stable agriculture. Also, over a long period of time, it makes for a more profitable enterprise; for, after all, though the need of the general public for animal products creates a demand for them, farmers would not engage in livestock production without a profit incentive.

Other Functions of Animals

Livestock have other values. Every day millions of people use animal products for their health, enjoyment, amusement, beautification, and general happiness. Livestock are not processed for meat and hides alone. The insulin that keeps the diabetic alive and innumerable other by-products which contribute to the

welfare of society would not be possible without the livestock and meat industry.

SOME FACTORS TO CONSIDER IN ESTABLISHING THE LIVESTOCK ENTERPRISE

It is not intended that this section shall cover all of the multiple factors that should be considered in establishing a livestock enterprise. Rather, it is hoped that thought may be focused on some of the primary factors that should be considered if the venture is to be successful.

Systems of Farming

Three broad systems of farming are practiced in the United States: (1) crop farming, (2) livestock farming, and (3) crop and livestock farming combined. Because considerable variation exists within each classification, some farm management specialists prefer further and more refined divisions. For example, instead of placing crop farming in one category, there are those who list one-crop farms and diversified-crop farms as two separate systems of farming. For purposes of this discussion, however, the three broad classifications will be used, with each system of farming defined as follows:

1. **Crop farming** is that system in which crops are grown that are useful for food, feed, or clothing—with the income derived from the sale of cash crops.

2. **Livestock farming** is that system in which the crops are used chiefly or entirely as a feed for animals—with the income derived from the sale of animals, meat, milk, eggs, and wool.

3. **Crop and livestock farming combined** is that system that combines significant amounts of crop and livestock farming—with the income derived both from the sale of cash crops and animals and their by-products.

Leading Livestock States of the United States

It is but natural to find, in a country so large and variable as the United States, that some areas and states are better adapted to livestock production than others. Though the size of land area within each of the forty-eight states varies considerably and, consequently, is a major factor in determining the total livestock population of each, the cash receipts of livestock and livestock products by states is one of the best available criterion of the general livestock adaptation of the respective states. This information is presented in Table 6.

TABLE 6

LEADING LIVESTOCK STATES BY RANK BASED ON 1948 CASH RECEIPTS OF LIVESTOCK AND LIVESTOCK PRODUCTS[1]

State	Cash receipts of livestock and livestock products
	(in 1,000 dollars)
Iowa	1,760,706
Illinois	1,137,073
Wisconsin	1,002,467
Minnesota	913,718
Texas	882,947
California	830,636
Missouri	814,465
Indiana	755,254
Ohio	740,363
Nebraska	676,166
New York	654,010
Pennsylvania	619,725
Kansas	542,596
United States total	17,060,778

[1] *Agricultural Statistics*, 1948, U. S. Dept. of Agri., 1949, p. 632.

As, over a long period of time, farmers and ranchers do those things which are most profitable to them, there is perhaps considerable logic in assuming that there exists in these leading livestock states a set of conditions making for successful livestock production. This fact is of importance to those who wish to get established in the livestock business in an adapted area.

Kind of Livestock Adapted to the Region

Some regions or areas of the United States possess a combination of feed and economic conditions that make them best adapted to a particular kind or kinds of livestock. Available feeds are determined chiefly by climate, soil, and topography; whereas economic conditions are determined by markets, available labor, transportation facilities, and perishability of product.

Because of a combination of feed and economic conditions, the following kinds of livestock farming predominate in different regions or areas of the United States:

The dairy region.—This region includes the densely populated northeastern part of the United States, extending from southern Minnesota north and east. The rainfall and climate of the area are well adapted to the production of pasture, hay, silage

crops, and oats—important crops for the dairy ration. In addition, there are excellent and nearby markets for milk, a highly perishable product.

The Corn Belt.—This region refers to the seven Corn Belt states of Iowa, Illinois, Nebraska, Missouri, Kansas, Indiana, and Ohio. The climate, soil, and topography of the area are well suited to the production of corn, the principal crop; and corn is pre-eminently adapted to the fattening of hogs and cattle. Also, the Corn Belt feed lots are in close proximity to the largest livestock markets in the world.

The Cotton Belt.—This region, which derives its name from its predominant crop, is confined to southeastern United States. Corn is the second most important crop of the area, and there is a considerable acreage of peanuts, sweet potatoes, and other crops, part or all of which are fed to animals. More important, from the standpoint of efficient livestock production, year-round pastures are possible in this area. The combination of a mild climate, a variety of crops, and a long grazing season makes the Cotton Belt well adapted to most all types of livestock production. From an economic standpoint, the region has an abundance of comparatively cheap labor, but satisfactory market outlets are in need of further development.

The western range.—This region comprises the great ranching area of the United States which lies west of the one hundredth meridian. The extensive grazing areas of this territory are especially suited to the production of lambs and wool and feeder cattle—highly concentrated and non-perishable products that may be economically and successfully transported great distances to market.

Although regional adaptations are important and should always be given careful consideration when selecting the livestock enterprise, it is well to keep in mind that some regions are almost equally well suited to other kinds of livestock than those for which they are most noted. For example, the Corn Belt states are well adapted to and support a considerable number of animals other than hogs and beef cattle—including sheep, dairy cattle, poultry, and horses. Likewise, poultry successfully competes with dairy cattle in northeastern United States, and some of the more isolated grazing areas of the dairy belt are best adapted to beef production. Also, some of the irrigated valleys of the far west are noted for their large cattle and sheep feeding yards—largely because of their cheap and abundant by-product feeds.

Kind of Livestock Adapted to the Farm or Ranch

Under some conditions a hog farmer may have one neighbor who is a cattle feeder, a second who operates a dairy, a third who keeps a sizeable farm flock of sheep, a fourth who produces light horses for recreation and sport, and a fifth whose chief source of income is from poultry. All may be successful and satisfied with their respective livestock enterprises. This indicates, therefore, that several types of livestock farming may be nearly equally well adapted to an area or region. This means that the selection of the dominant type of livestock enterprise should be analyzed from the standpoint of the individual farm or ranch.

Usually a combination of several factors suggests the livestock enterprise or enterprises best adapted to a particular farm or ranch. The following summary may be of assistance in arriving at a decision as to the kind or kinds of livestock best suited to the individual farm or ranch:

Kind of stock	*Characteristics*	*Where they fit*
Dairy	High returns for feed and labor.	Long on labor. Intensive farming.
Poultry	Low returns for labor. Relatively low capital required.	Short on concentrated feed. Limited capital. Special markets.
Hogs	High labor return. Medium feed return. Medium capital requirement.	Corn abundant. Sanitation possible.
Beef and lamb feeding	Highly speculative. High labor return, long run. Relatively low feed returns. High capital requirements.	Long on grain. Adequate roughage. Limited labor. Strong finances. Adequate "know-how" of buying, feeding, and marketing.
Beef and lamb breeding	Low labor returns. Low feed returns. Moderate capital requirements.	Very long on roughage. Little or no grain. Grain fed higher-profit stock.

Requisites of a Successful Stockman

The first and most important requisite of a successful stockman is that he must possess a great love for animals. This appears to be an inborn trait, for some people never acquire a natural ability to work with animals—no matter how long or how hard they try. When such love for stock exists, animals are more docile and handle with greater ease, for the caretaker's feelings are relayed to his charges. Also, a great love for animals appears to be essential if the caretaker is to feed them regularly, cheerfully, and with enjoyment, without regard to long hours and Sundays or holidays; if he is to provide clean dry bedding, despite the fact that a driving storm may make it necessary to

repeat the same operation the next day; if he is to serve as "nursemaid" to newborn or sick animals, though it may mean the loss of sleep and working with cold, numb fingers; and if he is to remain calm and collected, though striking an animal or otherwise giving vent to his feelings might at first appear to be warranted.

Next to having a great love for animals, it is important that the successful stockman have adequate knowledge of the broad field of animal science. In addition, a good stockman must be well versed relative to soils and crops, for in most successful livestock enterprises the feeds are home grown. In general, this means that the livestock farmer or rancher should be equally as competent as the grain farmer from the standpoint of raising feeds, and, in addition, he must be thoroughly competent in the production and marketing of animals. Successful livestock farming requires great skill.

Finally, experience, industry, and good judgment are very necessary requisites of a successful stockman. These words carry the same connotation in all industries and are self-explanatory.

Quality of Livestock to Keep

Once the kind or kinds of animals has been decided upon, good foundation stock should be selected, and they should receive proper care. A combination of good breeding and husbandry are prerequisites to high and efficient production as indicated by: (1) saving a high percentage of newborn animals, (2) efficient feed utilization, and (3) high production of meat, milk, eggs, and wool. There is much truth in the statement that livestock of superior breeding, properly fed and managed, are the "brand" of the successful farm or ranch.

Though preference should be a major factor in selecting a breed, it should be remembered that there are more differences within breeds than between breeds.

PUREBREDS CONTROL DESTINY OF THE LIVESTOCK BUSINESS

The reader of this and other similar books in the field of animal husbandry might formulate the impression that too great emphasis is placed on purebreds. After all, it may be argued, only about 1 per cent of the dairy cattle and somewhere between 2 and 3 per cent of the beef cattle, sheep, horses, and swine of the United States are registered purebreds. The remaining and vast majority of animals are of the commercial variety. Moreover,

the ultimate objective of beef, sheep and swine production is meat over the block. In view of these facts, therefore, the uninformed is prone to ask why so much emphasis in the field of animal science is placed on purebreds.

The answer is simple. Purebreds control the destiny of the livestock business. They are a small but mighty minority. True enough, there is nothing sacred about purebreds, and the word itself does not imply any magic. It is generally agreed, however, that purebreds have been the major factor in the animal improvement of the past and that they will continue to exert a powerful influence in the future.

Certainly, the commercial stockmen are rather generally making use of purebred sires. In fact, following generations of grading up, many commercial herds closely resemble many a purebred herd in their uniformity of good conformation and quality. Any skeptic has but to review the breeding of the winning steers throughout the great livestock shows of the land in order to be convinced of the veracity of this statement. Such progress in the improvement of the commercial herds of the country has been most commendable, and the purebred breeder may well be proud of his role in this accomplishment. Yet, this very achievement is within itself a real challenge to the purebred breeder, for the future improvement of the better commercial herds of the country is directly dependent upon the further improvement of the purebred herds—the source of seed stock, particularly of sires. In other words, the farmer or rancher must have superior purebred sires to draw upon if he is to work further improvement in a commercial herd which already closely approaches the purebreds.

It is up to the purebred breeders to move ahead. In the past, purebreds have contributed immeasurably to commercial herds and flocks from the standpoint of superior conformation and type and greater market value. In the future, improvement should and will include as an added requirement greater efficiency of production.

NEW ANIMAL FRONTIERS THROUGH RESEARCH

The whole world became research conscious in World War II. Already historians are recording that victory came through research, the most notable accomplishment of which was the development and unleashing of the atom bomb. Now we are in an atomic age, and all industry—including the livestock business—must be geared to it.

In the final analysis, research has as its noble objectives the prolonging of life, the improvement of health and comfort, the enhancing of happiness, and the enlargement of productive ability and usefulness. To these ends, throughout the industrial world, thought is focused on greater efficiency of production, new products and materials, new processes and methods, and the elimination of wastes—factors essential to human welfare and upon which the very survival of industry is dependent. It must be just so with the livestock industry. The producer of animals cannot survive in a changing world by clinging to antique methods while the rest of industry forges ahead through applying new and scientific methods. There is great need for more animal research through which greater efficiency of production may be attained.

Industry has long been cognizant of the new frontiers possible through research, but unfortunately agriculture has lagged behind. It has been estimated that the total expenditures for industrial research in the United States in the year of 1946 were $450,000,000; whereas, the corresponding figure for all of United States agricultural research during the same year was only $52,739,000.[1] The DuPont Company alone spends annually from $15,000,000 to $20,000,000[2] on research—approximately 40 per cent of the total spent by all United States agriculture. It is further interesting to note a breakdown on the annual gross sales reinvested in research by different types of industries. The chemical and allied industries reinvest from 3 to 4 per cent of gross sales in research; the machinery industry, transportation equipment industry, and forest products industry, around 2 per cent; paper and allied products, printing and publishing, stone, clay, and glass products, iron and steel products other than machinery, and nonferrous metals and their products, between 1 and 2 per cent; food and related products, and leather and its manufactures, less than 1 per cent; and United States agriculture a mere one-fourth of 1 per cent.[3]

[1] Estimates of total expenditures for all industrial research provided in letter to author by Mr. A. E. Roach, Tech. Data Dept., Research Laboratories Div., General Motors Corp., Detroit, Mich.; agricultural estimated expenditures provided in letter to author from Dr. E. V. Eiting, Asst. Chief, Office of Expt. Sta., U. S. Dept. of Agri.

[2] Figures provided in letter to author from Mr. Jas. K. Hunt, E. I. DuPont de Nemours & Co, Wilmington, Del.

[3] Industry figures taken from report of the National Research Council to the National Resources Planning Board, Dec., 1940. Agricultural figures provided in letter to author from Mr. E. C. Eiting, Asst. Chief, Office of Expt. Sta., U. S. Dept. of Agri.

If the combined phases of animal research in the twentieth century have merely resulted in the saving of 50 cents per 100 pounds of meat produced—and certainly this figure cannot be based on more than conjecture, the actual accrued value of research being an intangible thing—the monetary value of research in producing 112,928,000,000 pounds of meat during the 5 war years, 1941 through 1945, would total $564,640,000. This is a staggering sum, indeed. Yet most people probably would agree that the accrued benefits derived from animal research—including disease and pestilence control, improved nutrition and breed-

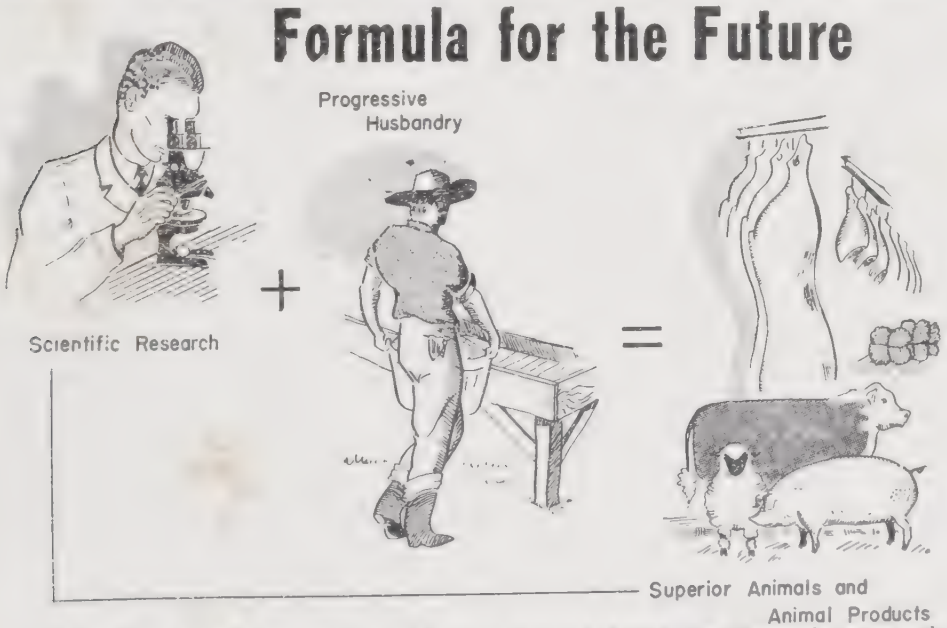


Fig. 15. Artist's conception of new animal frontiers through research. (Drawing by R. F. Johnson.)

ing, marketing and meats, and various phases of production and management—would far exceed any 50 cents per 100 pounds of meat produced. For example, among the most productive animal research is that which has made it possible to avoid large losses from insects and diseases; yet this is very difficult to evaluate in actual dollars and cents.

The pioneer work on the control of hog cholera cost about $50,000, but this work has been returning dividends for nearly forty years at the rate of $10,000,000 to $15,000,000 a year.[1]

When the first cow testing association was organized 40 years ago, the cows under test produced an average of 215 pounds of butterfat per year. Now a million cows in dairy herd improve-

[1] Figures from 1946 Annual Report of W. V. Lambert, Agricultural Research Administrator, U. S. Dept. of Agri.

ment associations are each producing an average of 339 pounds annually. When computed at 50 cents per pound, this yearly increase of 124 million pounds of butterfat represents an added total income to members of $60,000,000 per year.[1] Much of this added revenue is a reflection of improved breeding, feeding, and management practices discovered through research.

Livestock men recognize the remarkable effectiveness of phenothiazine for removing many kinds of internal parasites of livestock. In fact, it is now the most widely used drug for this purpose. Its chief value is that it can be used for many different classes of animals and can be administered easily. The cost of this discovery is estimated at $10,000, whereas its value approximates $10,000,000 annually.[1]

The insecticide DDT has already proved itself a powerful new weapon in the civilian war against insect pests, effecting an estimated annual saving of $10,000,000 to owners of beef and dairy cattle.[1]

In addition to the above more tangible examples of the value of research, it is recognized that in many cases, it is impossible to assign a dollar value to the results of investigational projects. Many times, no financial return is ever anticipated. The research is done solely for the sake of knowledge, which was the case in the early experiments on hybrid corn. After all, the development of hybrid corn was pretty much a happenstance. Back in the nineties, the late Professor Morrow, of the University of Illinois, first began a study of inbreeding corn. As a practical man, however, he abandoned the study when he noted the loss of vigor in his experimental plants. Later, in 1905, two "pure" scientists in Connecticut—in New England rather than in the Corn Belt—began a technical study of inbreeding and hybridization, using corn merely because it happened to be a convenient plant. They were interested in discovering basic principles, but out of their probing the entire hybrid corn industry developed.

Finally, it should be emphasized that research can make the information available, but it is still up to each individual—each farmer and rancher—to secure and apply the results.

No one can accurately forecast what lies ahead for the livestock industry. The past has been good, but to pause in a changing world is to retrogress. Certainly there is a challenge to meet when it is realized that existing animals vary so much in their efficiency of production and quality of products produced.

[1]Figures from 1946 Annual Report of W. V. Lambert, Agricultural Research Administrator, U. S. Dept. of Agr.

CHAPTER II

SOME PRINCIPLES OF GENETICS AND ANIMAL BREEDING[1]

Selection followed by mating of the "best with the best" has long been the principal tool through which man has attempted to bring about the improvement of domestic animals. Following the domestication of livestock, man began to choose certain animals for breeding while others were slaughtered and eaten. Until very recent times, the general principle that "like begets like" was the only recognized law of heredity. That the application of this principle over a long period of time has been effective in modifying animal types in the direction of selection is evident from a comparison of present-day types of animals within each class of livestock. Thus, the speed of representatives of the modern thoroughbred—coupled with their general lithe, angular build and nervous temperament—is in sharp contrast to the slow, easy gaits and the docility of the Tennessee Walking Horse. Yet there is good and substantial evidence to indicate that both breeds descended from a common ancestry. Because of the diversity of genes carried by the original parent stock, it has been possible, through selection, to evolve with two distinct breeds—one highly adapted to fast running races and the other to a slow, ambling gait. Also, through selection accompanied by planned matings, this same parent stock has been altered into horses especially adept as hunters, jumpers, stock horses, polo mounts, three- and five-gaited park hacks, harness race horses, etc. Through selection and controlled matings, man has also developed the many diverse types and breeds of cattle, sheep, and swine.

There can be little doubt that men like Bakewell, the English patriarch, and other eighteenth-century breeders had made a tremendous contribution in pointing the way toward livestock

[1]The author gratefully acknowledges the helpful suggestions of the following authority in genetics and animal breeding who reviewed chapters II, XIII, XXI, XXX, and XLIII: Dr. E. J. Warwick, Geneticist, Bureau of Animal Industry, U.S.D.A., and Professor of Animal Husbandry, University of Tennessee, Knoxville, Tennessee. In the preparation of this chapter, the author has drawn heavily, in both ideas and pictures, from Washington Agricultural Experiment Stations Bulletin No. 189 by E. J. Warwick.

improvement before Mendel's laws became known to the world in the early part of the twentieth century. Robert Bakewell's use of progeny testing through his ram letting was truly epoch making, and his improvement of Shire horses and Longhorn cattle was equally outstanding. He and other pioneers had certain ideals in mind, and according to their standards, they were able to develop some nearly perfect specimens. These men were intensely practical, never overlooking the utility value or the market requirements. No animal met with their favor unless such favor was earned by meat upon the back, milk in the pail, weight and quality of wool, pounds gained for pounds of feed consumed, draft ability, or some other performance of practical value. Their ultimate goal was that of furnishing better animals for the market or lowering the cost of production. It must be just so with the master breeders of the present and future.

Others took up the challenge of animal improvement where Bakewell and his contemporaries left off, slowly but surely molding animal types. Thus, during the past hundred years, remarkable progress has been made in breeding better meat animals—animals that are more efficient and, at the same time, that produce cuts of meat more nearly meeting the exacting requirements of the consuming public. The Texas Longhorn steer—built for stamina and ability to fight and producing tough, stringy meat—has been replaced by the earlier-maturing, prime bullock. The wild boar and the Arkansas razorback have been replaced by the modern meat and bacon types of swine; and the black, brown, and multi-colored sheep have been replaced by the present-day mutton and wool breeds.

Despite the remarkable progress of the past, much remains to be done. A casual glance at the daily receipts of any public stockyards is convincing evidence of the task ahead. The challenge is primarily that of improving the great masses of animals in order that more of them may approach the too few nearly perfect specimens. Moreover, in this atomic age, there must be greater efficiency of production; and this means more rapid growth, less feed to produce one hundred pounds of meat, and lifting of the percentage calf, lamb, and pig crops well above the present United States averages. With the experience of the pioneers to guide us and with our present knowledge of genetics and physiology of reproduction, progress should now be much more certain and rapid. In the past, animal breeding has been an art. In the future, it is likely to be both an art and a science.

MENDEL'S CONTRIBUTION TO GENETICS

Modern genetics was really founded by Gregor Johann Mendel, a cigar-smoking Austrian monk, who conducted breeding experiments with garden peas from 1857 to 1865, during the time of the Civil War. In his monastery at Brünn (now Brno, in Czechoslovakia), Mendel applied a powerful curiosity and a clear mind to reveal some of the basic principles of hereditary transmission. In 1866, he published in the proceedings of a local



Fig. 16. Gregor Johann Mendel (1822-1884), a cigar-smoking Austrian monk, whose breeding experiments with garden peas founded modern genetics. (Courtesy, Bettmann Archives.)

scientific society a report covering eight years of his studies, but for thirty-four years his findings went unheralded and ignored. Finally in 1900, sixteen years after Mendel's death, three European biologists independently duplicated his findings, and this led to the dusting off of the original paper published by the monk thirty-four years earlier. It is of further interest to note that W. J. Spillman, of the U. S. Department of Agriculture, who was stationed at The State College of Washington, Pullman, Washington, rediscovered some of Mendel's principles and pub-

lished his results in 1901 without prior knowledge that they had been rediscovered by the European biologists the previous year.

The essence of Mendelism is that inheritance is by particles or units (called genes), that these genes are present in pairs—one member of each pair having come from each parent—and that each gene maintains its identity generation after generation. Thus, Mendel's work with peas laid the basis for two of the general laws of inheritance: (1) the law of segregation, and (2) the independent assortment of genes. Later genetic principles have been added; yet all the phenomena of inheritance, based upon the reactions of genes, are generally known under the collective term, Mendelism.

Thus modern genetics is really unique in that it was founded by an amateur who was not trained in science and who did his work merely as a hobby. During the years since the rediscovery of Mendel's principles (in 1900), many additional genetic principles have been added, but the fundamentals as set forth by Mendel have been proved correct in every detail. It can be said, therefore, that inheritance in both plants and animals follows the biological laws discovered by Mendel.

SOME FUNDAMENTALS OF HEREDITY

The author has no intention of covering all of the diverse field of genetics and animal breeding. Rather, he will present a condensation of the known facts in regard to the field and will briefly summarize their applications to practical operations. Some of the fundamentals of heredity will be treated under the following headings: (1) the gene as the fundamental unit of genetics, (2) genes seldom change, (3) a simple type of inheritance, (4) dominant and recessive factors, and (5) most characters due to multiple-gene situation.

The Gene As The Fundamental Unit of Genetics

Genes determine all the hereditary characteristics of animals, from the body type to the color of the hair. They are truly the fundamental unit of genetics.

The bodies of all animals are made up of millions or even billions of tiny cells, microscopic in size. Each cell contains a nucleus in which there are a number of pairs of bundles, called chromosomes. In turn, the chromosomes carry pairs of minute particles, called genes, which are the basic hereditary material. The nucleus of the body cells of cattle and horses each contain

thirty pairs of chromosomes[1], or a total of sixty, whereas there are perhaps thousands of pairs of genes. These genes determine all the hereditary characteristics of living animals. Thus, inheritance goes by units rather than by the blending of two fluids, as our grandfathers thought.

Schematic Drawing of a Pair of Chromosomes

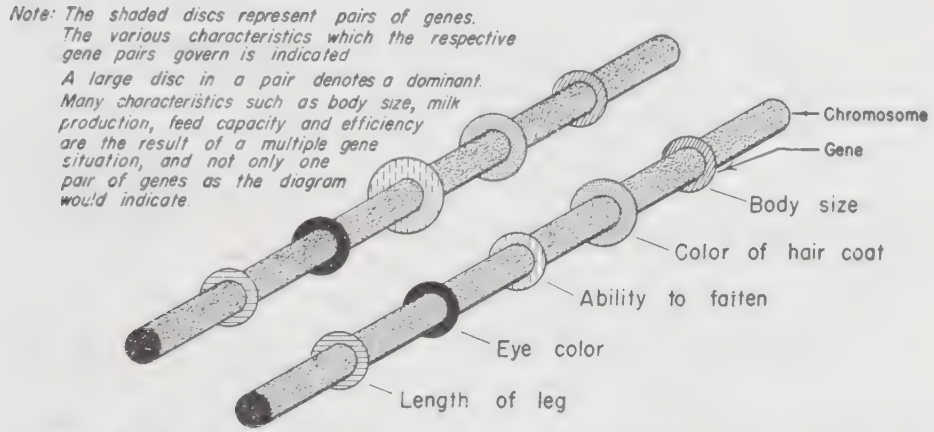


Fig. 17. A pair of bundles, called chromosomes, carrying minute particles, called genes. The genes determine all the hereditary characteristics of living animals, from length of leg to body size. (Drawing by R. F. Johnson.)

The modern breeder knows that the job of transmitting qualities from one generation to the next is performed by the germ cells—a sperm from the male and an ovum or egg from the female. All animals, therefore, are the result of the union of two such tiny cells, one from each of its parents. These two germ cells contain all the anatomical, physiological, and psychological characters that the offspring will inherit.

In the body cells of an animal, each of the chromosomes is duplicated; whereas in the formation of the sex cells, the egg and the sperm, a reduction division occurs and only one chromosome and one gene of each pair goes into a sex cell. This means that only half the number of chromosomes and genes present in the body cells of the animal go into each egg and sperm, but each sperm or egg cell has genes for every characteristic of its species. As will be explained later, the particular half that any one germ cell gets is determined by chance. When mating and

[1]Sheep have fifty-four and swine thirty-eight.

fertilization occur, the single chromosomes from the germ cell of each parent unite to form new pairs, and the genes are again present in duplicate in the body cells of the embryo.

With all possible combinations in thirty pairs of chromosomes (the specie number in cattle and horses) and the genes that they bear, any sire or dam can transmit over one billion

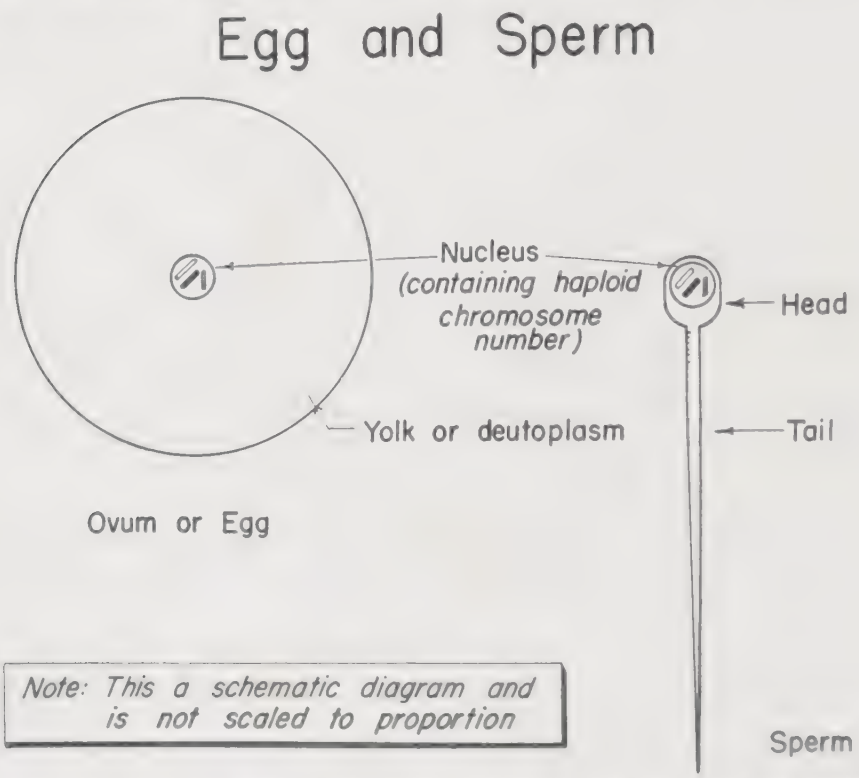


Fig. 18. Egg and sperm. The parent germ cells, the egg from the female and the sperm from the male, unite and transmit to the offspring all the characters that it will inherit. (Drawing by R. F. Johnson.)

different samples of its own inheritance; and the combination from both parents makes possible one billion times one billion genetically different offspring. It is not strange, therefore, that no two animals within a given breed (except identical twins from a single egg split after fertilization) are exactly alike. We can marvel that the members of a given breed bear as much resemblance to each other as they do.

Even between such closely related individuals as full sisters it is possible that there will be quite wide differences in size, growth rate, temperament, conformation, and in almost every

conceivable character. Admitting that many of these differences may be due to undetected differences in environment, it is still true that in such animals much of the variation is due to hereditary differences. A sire, for example, will sometimes transmit to one offspring much better inheritance than he does to most of his get, simply as the result of chance differences in the genes that go to different sperm at the time of the reduction division. Such difference in inheritance in offspring has been called both the hope and the despair of the livestock breeder.

If an animal gets similar determiners or genes from each parent, it will produce a uniform set of offspring; because any half of its inheritance is just like any other half. For example, regardless of what combination of chromosomes go into a particular germ cell, it will be just like any other egg or sperm from the same individual. Such animals are referred to as being homozygous. Unfortunately, very few of our animals are in this happy hereditary state at the present time. Instead of being homozygous, they are heterozygous. This explains why there may be such wide variation within the offspring of any given sire or dam. The wise and progressive breeder recognizes this fact, and he insists on the production records of all get rather than that of just a few meritorious individuals.

Variation between the offspring of animals that are not pure or homozygous, to use the technical term, is not to be marveled at, but is rather to be expected. No one would expect to draw exactly thirty-five sound apples and fifteen rotten ones every time he took a random sample of fifty from a barrel containing seventy sound ones and thirty rotten ones, although on the average—if enough samples were drawn—he would expect to get about that proportion of each. Individual drawings would of course vary rather widely. Exactly the same situation applies to the relative numbers of "good" and "bad" genes that may be present in different germ cells from the same animal. Because of this situation, the mating of a mare with a fine track record to a stallion that on the average transmits relatively good performance will not always produce a foal of a merit equal to that of its parents. The foal could be markedly poorer than the parents or, happily, it could in some cases be better than either parent. The same situation applies to matings within all species of farm animals.

Selection and close breeding are the tools through which the stockman can obtain sires and dams whose chromosomes and

genes contain similar hereditary determiners—animals that are genetically more homozygous.

Genes Seldom Change

Gene changes are technically known as *mutations*. A mutation may be defined as a sudden variation which is later passed on through inheritance and that results from changes in a gene or genes. Mutations are not only rare, but they are prevailingly harmful. For all practical purposes, therefore, the genes can be thought of as unchanged from one generation to the next. The



Fig. 19. The polled Hereford bull Ginat 101740AHR 1APHR, the sire that Warren Gammon used most extensively beginning in 1901. The occurrence of the polled characteristic within the horned Hereford breed is an example of a mutation or "sport" of economic importance. Out of this gene change arose the Polled Hereford breed of cattle. (Courtesy, B. O. Gammon, Secretary Emeritus, American Polled Hereford Association.)

observed differences between animals are usually due to different combinations of genes being present rather than to mutations. Each gene probably changes only about once in each 100,000 to 1,000,000 animals produced.

Once in a great while a mutation occurs in a farm animal, and it produces a visible effect in the animal carrying it. These animals are commonly called "sports." Such "sports" are occasionally of practical value or of value in establishing such things as breed trademarks. The occurrence of the polled characteristic within the horned Hereford and Shorthorn breeds is an example of a mutation or "sport" of economic importance. Out of this has arisen the Polled Hereford and Polled Shorthorn breeds of cattle.

Gene changes can be accelerated by exposure to X-rays, radium, and ultraviolet light. Such changes may eventually be observed in the offspring of both people and animals of Japan who were exposed to the atom bombs unleashed in World War II.

A Simple Type of Inheritance[1]

In the simplest type of inheritance, only one pair of genes is involved. Thus a pair of genes is responsible for the color of hair in Shorthorn cattle. An animal having two genes for red is actually red in color, whereas an animal having two genes for white is white in color. On the other hand, a Shorthorn which has one gene for red and one for white, is neither red nor white but roan, which is a mixture of red and white. Thus, red X white matings in Shorthorn cattle usually produce roan offspring. Likewise, white X white matings generally produce white offspring; but it must be remembered that white in Shorthorns is seldom pure, for the face bristles, eyelashes, and ears usually carry red hairs. Roans, having one gene for red and one for white on the paired chromosomes will never breed true and, if mated together, will produce calves in the proportion of one red, two roans, and one white. If one wishes to produce roans, the most certain way is to mate red cows with a white bull or vice versa, for then all the calves will be roan. If a roan animal is bred to a red one, one-half the offspring will be red, whereas the other half will be roan. Likewise, when a roan animal is bred to a white one, approximately an equal number of roan and white calves will be produced.

It should be borne in mind that the various gene combinations, such as referred to above, occur at random and that the various colors will appear in the offspring in the proportions indicated only when relatively large numbers are concerned. The possible gene combinations, therefore, are governed by the laws of chance, operating in much the same manner as the results obtained from flipping coins. For example, if a penny is flipped often enough, the number of heads and tails will come out about even. However, with the laws of chance in operation, it is possible that out of any four tosses one might get all heads, all tails, or even three to one. In exactly the same manner, a

[1]The Shorthorn color situation given in this section does not always occur as expected because of modifying factors with small effects. Apparently, the white color of Shorthorns is seldom pure. Moreover, there exists the spotted red and white Shorthorn, which is presumably of a different genetic combination, possibly somewhat similar to spotted Ayrshires and Holstein-Friesians.

Shorthorn breeder may be highly elated in obtaining four red calves from a roan X roan mating only to be greatly depressed when the next four calves, from the same matings, are white in color.

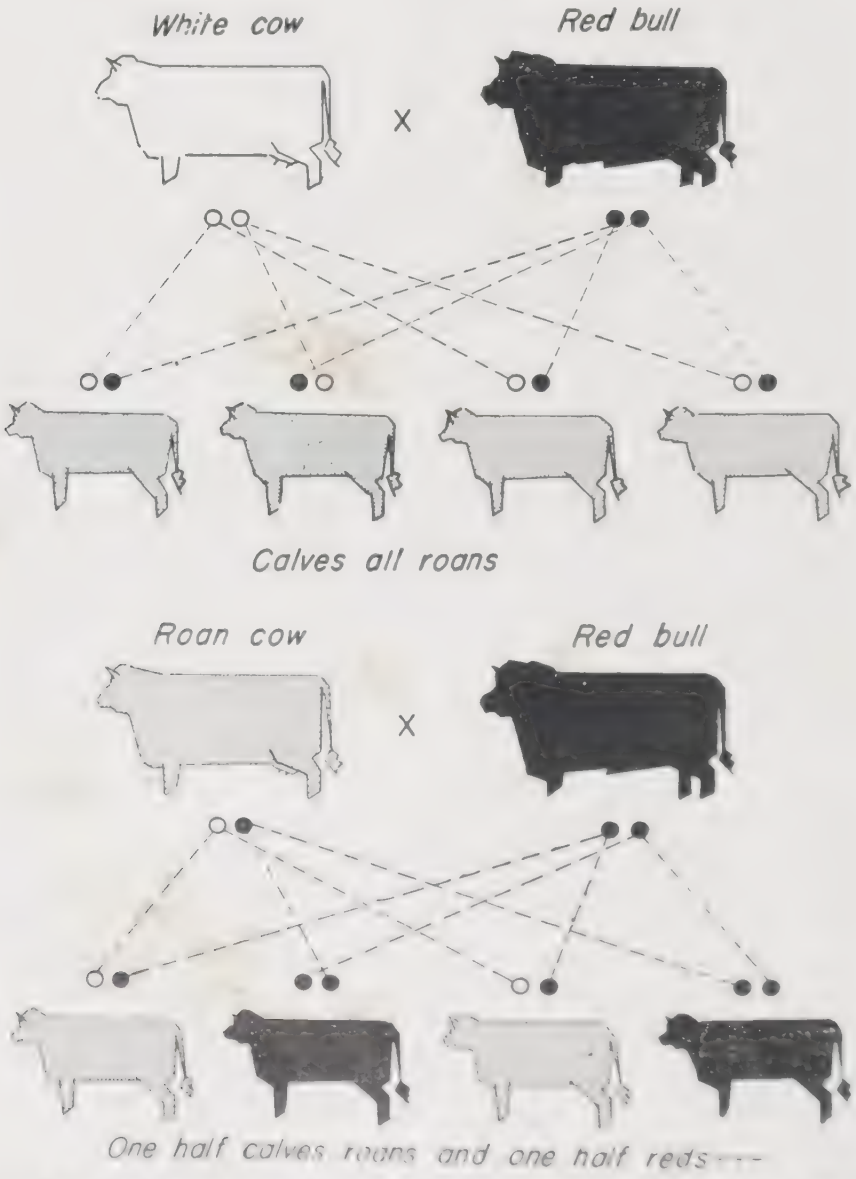


Fig. 9. Diagrammatic illustration of the inheritance of color in Shorthorn cattle. Red X white matings in Shorthorn cattle usually produce roan offspring; whereas roan X roan matings produce one-half red offspring and one-half roan offspring. (Drawing by E. F. Johnson.)

Dominant and Recessive Factors

In the example of Shorthorn colors, each gene of the pair produced a visible effect, whether paired as identical genes (two reds or two whites) or as two different genes (red and white). In other instances of single-factor inheritance, the phenomenon of "dominance" makes the result somewhat different. In this type of inheritance, a factor or gene has its full effect regardless of whether it is present with another just like itself or whether it is paired with a recessive gene.

In cattle, the polled character is dominant to the horned character. Thus, if a *pure polled* bull is used on horned cows (or vice versa), the resulting progeny are not midway between the two parents but are of polled character. It must be remembered, however, that not all hornless animals are pure for the polled character; many of them carry a factor for horns in the hidden or "recessive" condition. In genetic terminology, animals that are pure for a certain character—for example the polled characteristic are termed *homozygous*, whereas those that have one dominant and one recessive factor are termed *heterozygous*. A simple breeding test can be used in order to determine whether a polled bull is homozygous or heterozygous, but it is impossible to determine such purity or impurity through inspection. The breeding test consists of mating the polled sire with a number of horned females. If the bull is pure or homozygous for the polled character, all of the calves will be polled; whereas if he is impure or heterozygous, only half of the resulting offspring will, on the average, be polled and half will have horns like the horned parents. Many breeders of Polled Herefords or Polled Shorthorns test their herd sires in this manner, mating the prospective sire to several horned animals.

Another example of "dominance" is that of the white face of Hereford cattle—the white face being dominant over the type of coloration in which the head and body are of the same color. Undoubtedly, this condition of dominance, which constitutes a trademark of the breed, has been of importance from a promotional standpoint.

As can be readily understood, dominance often makes the task of identifying and discarding all animals carrying an undesirable recessive factor a difficult one. Recessive genes can be passed on from generation to generation, appearing only when two animals, both of which carry the recessive factor, happen to mate. Even then, only one out of four offspring produced

will, on the average, be homozygous for the recessive factor and show it.

In cattle, the red color in the Aberdeen-Angus breed is an example of such an undesirable recessive factor. Black polled cattle have been known in Scotland since 1523; and since the days of Hugh Watson, William McCombie, and George McPherson Grant, black has been the accepted color of the breed. Yet, down through the years, a recessive factor for red coat color has persisted in the breed. For this reason, a red calf occasion-

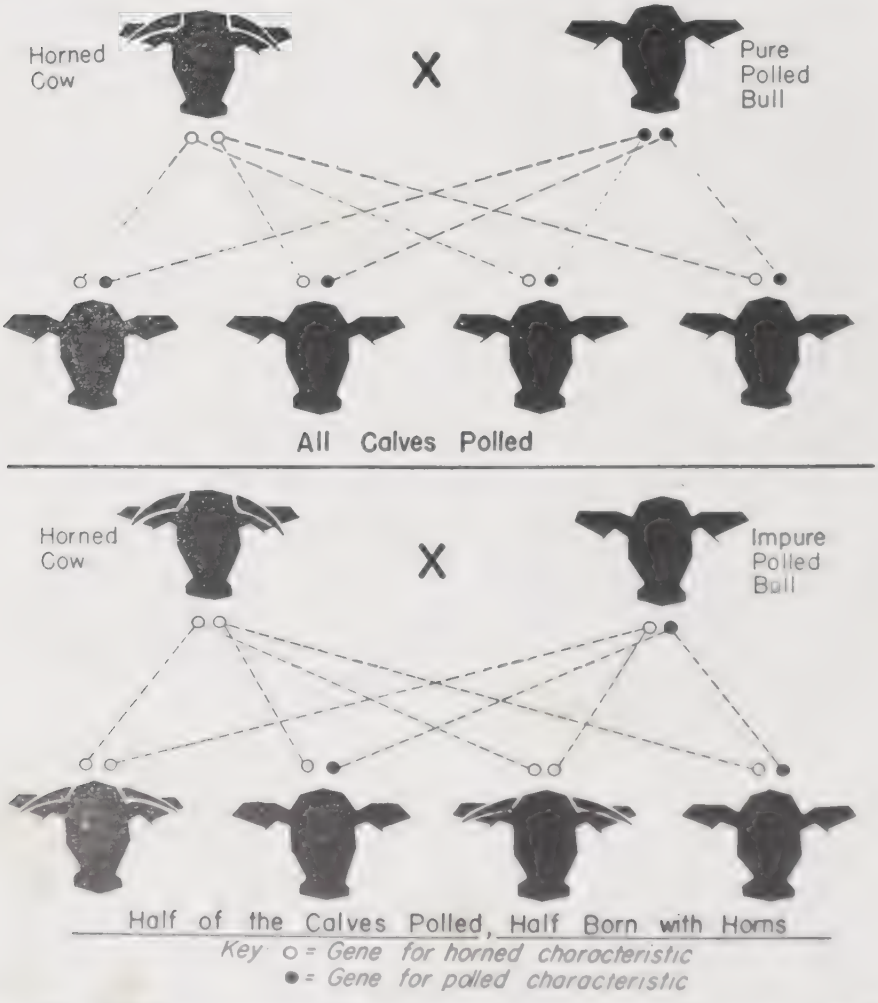


Fig. 21. Diagrammatic illustration of the inheritance of horns in cattle. If a bull that is pure or homozygous for the polled character is mated with a number of horned females, all of the calves will be polled, whereas if a bull that is impure or heterozygous for the polled character is mated with a number of horned females, only half of the calves will, on the average, be polled. (Drawing by M. F. Johnson.)

ally and unexpectedly shows up in a purebred Aberdeen-Angus herd (about one red calf appears in each two hundred Aberdeen-Angus calves dropped). This occasional appearance of a red calf in the Aberdeen-Angus breed does not signify any impurity of breeding but merely the outcropping of a long hidden recessive gene. When a red calf does appear, one can be very certain that both the sire and dam contributed equally to the condition and that each of them carries the recessive gene for red color. This fact should be given consideration in the culling program.



Fig. 22. Two purebred lambs of the same breed. The black sheep is the result of an undesirable recessive factor that was carried by both the sire and dam. Recessive genes can be passed on for many generations without their presence becoming evident until such time as two animals are mated both of which carry the same recessive factor. Even then, only one out of four offspring produced will, on the average, be homozygous for the recessive factor and show it. (Courtesy, The State College of Washington.)

As the factor for red is recessive, the red animals are pure for color. The mating of two red animals, therefore, will always produce red calves.

Assuming that a hereditary defect or abnormality has occurred in a herd or flock and that it is recessive in nature, the breeding program to be followed to prevent or minimize the possibility of its future occurrence will depend somewhat on the type of herd or flock involved—especially on whether it is a commercial or purebred herd. In an ordinary commercial herd, the breeder can usually guard against further reappearance of the undesirable recessive by simply using an outcross (unrelated) sire within the same breed or by crossbreeding with a

sire from another breed. With this system, the breeder is fully aware of the recessive being present, but he has taken action to keep it from showing up.

On the other hand, if such an undesirable recessive appears in a purebred herd or flock, the action should be more drastic. A reputable purebred breeder has an obligation not only to himself but to his customers among both the purebred and commercial herds. Purebred animals must be purged of undesirable genes and lethals. This can be done by:

1. Eliminating those sires and dams that are known to have transmitted the undersirable recessive character.

2. Eliminating both the abnormal and normal offspring produced by these sires and dams (approximately half of the normal animals will carry the undesirable character in the recessive condition).

3. By, in some instances, breeding a prospective herd sire to a number of females known to carry the factor for the undesirable recessive, thus making sure that the new sire is free from the recessive.

Such action in a purebred herd is expensive, and it calls for considerable courage. Yet it is the only way in which the purebred livestock of the country can be freed from such undesirable genes.

Most Characters Due To Multiple-Gene Situation

Relatively few characters of economic importance in farm animals are inherited in as simple a manner as the coat color or polled condition described. Commercial characters—such as meat production, milk and butterfat production, egg production, and wool production—are due to many genes; thus they are called multiple-factor characters or multiple-gene characters.

Estimates of the number of pairs of genes affecting each economically important characteristic vary greatly, but the majority of geneticists agree that for most such characters ten or more pairs of genes are involved. Growth rate in cattle, therefore, is affected by: (1) the animal's appetite or feed consumption; (2) the efficiency of assimilation—that is, the proportion of the feed eaten that is absorbed into the blood stream; and (3) the use to which the nutrients are put after assimilation—for example, whether it is used for growth or fattening. This example should indicate clearly enough that such an economic characteristic as growth rate is controlled by many genes and

that it is difficult to determine the mode of inheritance of such characters.

SEX DETERMINATION

On the average, and when considering a large population, approximately equal numbers of males and females are born in all common species of animals. To be sure, many notable exceptions can be found in individual herds. The history of The State College of Washington Aberdeen-Angus herd, for example, reads like a story book. The entire herd was built up from one foundation female purchased in 1910. She produced seven daughters. In turn, her first daughter produced six females. Most remarkable yet and extremely fortunate from the standpoint of building up the cow herd, it was four years before any bull calves were dropped in the herd.

Such unusual examples often erroneously lead the stockmen to think that something peculiar to the treatment or management of a particular herd resulted in a preponderance of males or females, as the case may be. In brief, through such examples, the breeder may get the impression that variation in the sex ratio is not random but that it is under the control of some unknown and mysterious influence. Under such conditions, it can be readily understood why the field of sex control is a fertile one for fraudulent operators. Certainly, any "fool-proof" method of controlling sex would have tremendous commercial possibilities. For example, cattlemen wishing to build up a herd could then secure a high percentage of heifer calves. On the other hand, the commercial cattleman would then elect to produce only enough heifers for replacement purposes. From an economical standpoint, he would want a preponderance of bull calves for the reason that commercial steers sell for a higher price than do commercial heifers. Unfortunately, no such method of sex control is known.

The most widely accepted theory of sex determination at the present time is that sex is determined by the chromosomal makeup of the individual. One particular pair of the chromosomes is called the sex chromosomes. In farm animals, the female has a pair of similar chromosomes (usually called X chromosomes), whereas the male has a pair of unlike sex chromosomes (usually called X and Y chromosomes). In the bird, this condition is reversed, the females having the unlike pair and the male having the like pair.

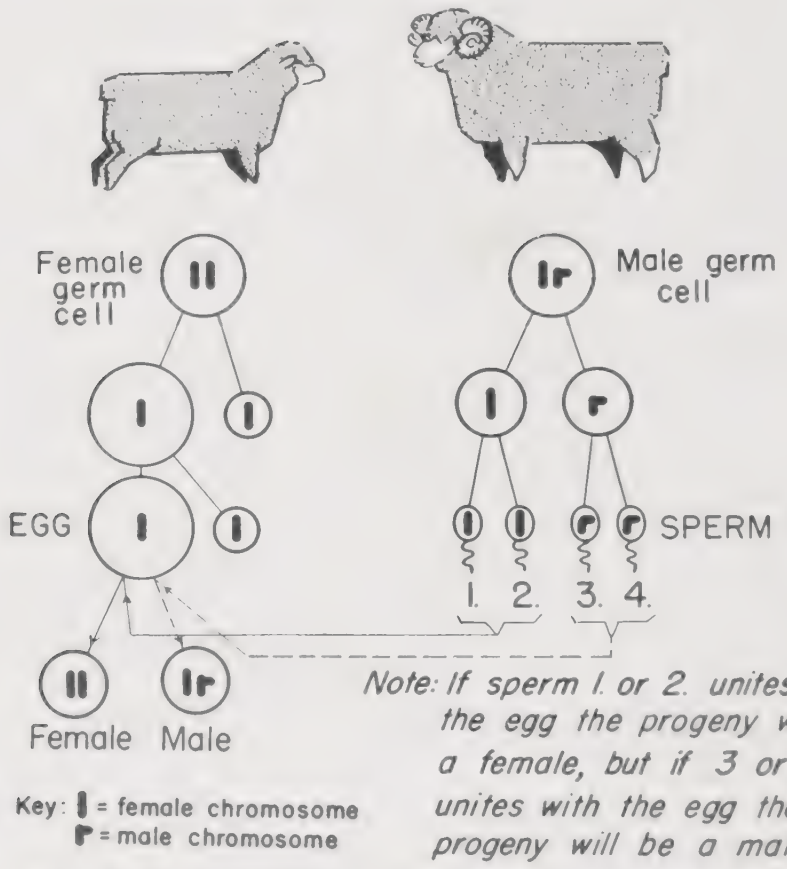


Fig. 23. Diagrammatic illustration of the mechanism of sex determination in farm animals, showing how sex is determined by the chromosomal makeup of the individual. The female has a pair of like sex chromosomes, whereas the male has a pair of unlike sex chromosomes. Thus, if an egg and sperm of like sex chromosomal makeup unite, the offspring will be a female; whereas if an egg and sperm of unlike sex chromosomal makeup unite, the offspring will be a male. (Drawing by R. F. Johnson.)

The pairs of sex chromosomes separate out when the germ cells are formed. Thus, each of the ova or eggs produced by the cow contains the X chromosome; whereas the sperm of the bull are of two types, one half containing the X chromosome and the other one half the Y chromosome. Since, on the average, the eggs and sperm unite at random, it can be understood that half of the progeny will contain the chromosomal makeup XX (females) with the other one half XY (males).

HEREDITY AND ENVIRONMENT

A massive purebred bull, standing belly deep in straw and with a manger full of feed before him, is undeniably the result

of two forces—heredity and environment (with the latter including training). If turned out on the range, an identical twin to the placid bull would present an entirely different appearance. By the same token, optimum environment could never make a champion out of a bull with scrub ancestry, but it might well be added that "fat and hair will cover up a multitude of sins."

These are extreme examples, and they may be applied to any class of farm animals; but they do emphasize the fact that any particular animal is the product of heredity and environment. Stated differently, heredity may be thought of as the foundation, and environment as the structure. Heredity has already made its contribution at the time of fertilization, but environment works ceaselessly away until death.

Experimental work has long shown conclusively enough that the vigor and size of animals at birth is dependent upon the environment of the embryo from the minute the ova or egg is fertilized by the sperm, and now we have evidence to indicate that newborn animals are affected by the environment of the egg and sperm long before fertilization has been accomplished. In other words, perhaps due to storage of factors, the kind and quality of the ration fed to young, growing females may later affect the quality of their progeny. Generally speaking, then, environment may inhibit the full expression of potentialities from a time preceding fertilization until physiological maturity has been attained.

It is generally agreed, therefore, that maximum development of characters of economic importance—growth, body form, milk or wool production, speed, etc.— cannot be achieved unless there are optimum conditions of nutrition and management. However, the next question is whether a breeding program can make maximum progress under conditions of suboptimal nutrition (such as is often found under farm and range conditions). This question is a controversial one among geneticists. One school of thought is that selection for such factors as body form and growth rate in cattle can be most effective only under nutritive conditions promoting the near maximum development of those characters of which the animal is capable. The other school of thought is that genetic differences affecting usefulness under suboptimal conditions will be expressed under such suboptimal conditions, and that differences observed under forced conditions may not be correlated with real utility under less favorable conditions. Those favoring the latter type of thinking argue, there-

fore, that the production and selection of breeding animals for the range should be under typical range conditions and that the animals should not be highly fitted in a box stall.

Admittedly, after looking over an animal or studying its production record, a breeder cannot with certainty know whether it is genetically a high or a low producer. There can be no denying the fact that environment—including feeding, management, and disease—plays a tremendous part in determining the extent to which hereditary differences that are present will be expressed in animals. Yet, it would appear to be more difficult to estimate



Fig. 24. Feed made the difference! The two sows are of the same age and breeding, but the sow shown in the picture at left received all she could eat from birth, whereas the gaunt sow shown in the picture at right was limited to 70 per cent of the ration consumed by the better fed animal. This 10-year experiment, under way at the State College of Washington, is designed to study the effect of plane of nutrition on meat animal improvement. (Courtesy. The State College of Washington.)

the possible effect of degree of suboptimal development than it would be to make selections on the basis of optimum environment. For this reason, it would seem logical that—if one desires to select for such characteristics as rapid growth; smooth thick fleshing; and maximum development in the regions of the high priced cuts—herd sire prospects should be reasonably well fitted rather than in range condition when selections are made.

Within the pure breeds of livestock—managed under average or better than average conditions—it has been found that, in general, only 15 to 30 per cent of the observed variation in a characteristic is actually brought about by hereditary variations. To be sure, if we contrast animals that differ very greatly in heredity—for example, a champion heifer and a scrub—90 per cent or more of the apparent differences in type may be due to heredity. The point is, however, that extreme cases such as the one just mentioned are not involved in the advancement within improved breeds of livestock. Here the comparisons are

between animals of average or better than average quality, and the observed differences are often very minor.

The problem of the progressive breeder is that of selecting the very best animals available genetically—these to be parents of the next generation of offspring in his herd. The fact that only 15 to 30 per cent of the observed variation is due to differences in inheritance and that environmental differences can produce misleading variations make mistakes in the selection of breeding animals inevitable. However, if the purebred breeder has clearly in mind a well-defined ideal and adheres rigidly to it in selecting his breeding stock, very definite progress can be made, especially if mild inbreeding is judiciously used as a tool through which to fix the hereditary material.

A progressive animal breeder—whether he be a purebred or a commercial breeder—attempts to reshuffle the genes and get them in a better working combination. To do this, he has three tools at his disposal: (1) cross-breeding, either between families or lines within a breed, or between breeds; (2) selection; and (3) inbreeding. The latter is a valuable tool to raise the prepotency of the characters that are being considered in selection; but in order that it may be successful, it is necessary that the herd be fairly large and that two or three sires be used.

It is also quite likely that better adapted strains or breeds of cattle need to be developed for different sections of the world and even for the diverse conditions existing in this large country. For example: the sparse vegetation under low-rainfall conditions in many sections of the Southwest offers considerable contrast to the lush pastures of the Corn Belt. Accordingly, it is quite likely that different types of animals should be produced in each area. In recognition of this fact, the King Ranch in Texas has developed the Santa Gertrudis breed of cattle. Finally, it may be said that it is highly questionable that a breed or strain of animals is well adapted to a certain area if, over a period of years, it is necessary to constantly go to outside areas for a high proportion of the breeding stock.

LETHALS AND ABNORMALITIES OF DEVELOPMENT

Lethals may be defined as congenital abnormalities which result in the death of an animal, either at birth or later in life. Other defects occur which are not sufficiently severe to cause death but which do impair the usefulness of the affected animals.

Many such abnormal animals are born on the nation's farms and ranches each year. Unfortunately, the purebred breeder, whose chief business is that of selling breeding stock, is likely to "keep mum" about the appearance of any defective animals in his herd because of the justifiable fear that it may hurt his sales. With the commercial producer, however, the appearance of such lethals as "bulldog calves" is simply so much economic loss, with the result that he generally, openly and without embarrassment, admits the presence of abnormality and seeks correction.



Fig. 25. A "bull dog" calf, a lethal condition that is the result of homozygous recessive genes. The animal was born alive and lived about an hour. (Courtesy, Prof. Graydon W. Brant, The Clemson Agricultural College.)

The embryological development—the development of the young from the time that the egg and the sperm unite until the animal is born—is very complicated. Thus the oddity probably is that so many of the offspring develop normally rather than that a few develop abnormally.

Many such abnormalities (commonly known as monstrosities or freaks) are hereditary, being caused by certain "bad" genes. Moreover, the bulk of such lethals are recessive and may, therefore, remain hidden for many generations. The prevention of such genetic abnormalities requires that the germ plasm be purged of the "bad" genes. This means that, where recessive lethals are involved, the stockman must be aware of the fact that both parents carry the gene. For the total removal of the

lethals, test matings and rigid selection must be practiced. The best test mating to use for a given sire consists of mating him to some of his own daughters.

In addition to hereditary abnormalities, there are certain abnormalities that may be due to nutritional deficiencies, or "accidents of development"—the latter including those which appear to occur sporadically and for which there is no well-defined reason. When only a few defective individuals occur within a particular herd, it is often impossible to determine whether their occurrence is due to: (1) defective heredity, (2) defective nutrition, or (3) merely to accidents of development. If the same abnormality occurs in any appreciable number of animals, however, it is probably either hereditary or nutritional. In any event, the diagnosis of the condition is not always a simple matter.

The following conditions would tend to indicate a hereditary defect:

1. If the defect had previously been reported as hereditary in the same breed of livestock.

2. If it occurred more frequently within certain families or when there had been inbreeding.

3. If it occurred in more than one season and when different rations had been fed.

The following conditions might be accepted as evidence that the abnormality was due to a nutritional deficiency:

1. If it had previously been reliably reported to be due to a nutritional deficiency.

2. If it appeared to be restricted to a certain area.

3. If it occurred when the ration of the mother was known to be deficient.

4. If it disappeared when an improved ration was fed.

If there is suspicion that the ration is defective, it should be improved, not only from the standpoint of preventing such deformities, but from the standpoint of good and efficient management.

If there is good and sufficient evidence that the abnormal condition is hereditary, the steps to be followed in purging the herd of the undesirable gene are identical to those already outlined for ridding the herd of an undesirable recessive factor. An inbreeding program, of course, is the most effective way in which to expose hereditary lethals in order that purging may follow.

SYSTEMS OF BREEDING

The many diverse types and breeds among each class of farm animals in existence today originated from only a few wild types within each species. These early domesticated animals possessed the pool of genes, which, through controlled matings and selection, proved flexible in the hands of man. In cattle, for example, through various systems of breeding, there evolved animals especially adapted to draft purposes, beef production, milk production, and dual-purpose needs. Animals with special adaptations and types were also developed in horses, sheep, and hogs. Each of the common systems of breeding will now be discussed briefly.

Perhaps at the outset it should be stated that there is no one best system of breeding or secret of success for any and all conditions. Each breeding program is an individual case, requiring careful study. The choice of the system of breeding should be determined primarily by size and quality of herd, finances and skill of the operator, and the ultimate goal ahead.

Grading Up

Grading up is that system of breeding in which purebred sires of a given pure breed are mated to native or grade females. Its purpose is to develop uniformity and quality and to increase performance in the offspring.

Many breeders will continue to produce purebred stock. However, the vast majority of animals in the United States—probably more than 97 per cent—are not eligible for registry. In general, however, because of the obvious merit of using well-bred sires, farm animals are sired by purebreds. In comparison with the breeding of purebreds, such a system requires less outlay of cash, and less experience on the part of the producer. However, even with this type of production, grading up of the herd through the use of purebred sires is always advocated. Thus one of the principal functions of the purebred breeder is that of serving as a source of seed stock—particularly of sires—for the breeder of grades. In brief, it is hoped that concentrated doses of "good" genes may be secured through the use of purebred sires. As the common stock is improved, this means that still further improvement and homozygosity for good genes is necessary in the purebreds, if they are to bring about further advancement in any grading-up program.

Naturally, the greatest single step toward improved quality and performance occurs in the first cross. The first generation of

such a program results in offspring carrying 50 per cent of the hereditary material of the purebred parent (or 50 per cent of the "blood" of the purebred parent, as many stockmen speak of it). The next generation gives offspring carrying 75 per cent of the "blood" of the purebred breed, and in subsequent generations the proportion of inheritance remaining from the original scrub females is halved with each cross. Later crosses usually increase quality and performance still more, though in less



Fig. 26. High-grade Shorthorn calves, the result of using registered Shorthorn bulls on grade Shorthorn cows since 1911. Grand Champion load of feeder calves at the 1949 National Western Stock Show, Denver; bred by Josef Winkler, Castle Rock, Colorado, and sold at a world's record price for feeder calves of $77.00 per cwt. to Fulton-Foxley and Co., commission merchants of Denver, for Father Flanagan Boys' Town of Boys' Town, Nebraska. (Courtesy, Josef Winkler.)

marked degree. After the third or fourth cross, the offspring compare very favorably with purebred stock in conformation, and only exceptionally good sires can bring about further improvement. This is especially so if the males used in grading up successive generations are derived from the same strain within a breed.

As evidence that cattle of high merit may be produced through grading up, it is interesting to note that many present-day champion steers are sired by purebred bulls but are out of high grade cows. High grade animals that are the offspring of several generations of outstanding purebred sires can be and often are superior to average or inferior purebreds.

Years of experience in grading up beef cattle through using registered Shorthorn bulls on good native red cows at Sni-A-Bar Farms, Grain Valley, Missouri, has yielded the following results and conclusions:

1. The greatest single step toward improved quality, compared with common stock, occurred in the first cross. Subsequent crosses increased quality and market value still more, though in less marked degree.

2. After the third and fourth cross, the offspring compared very favorably with purebred stock in conformation and quality, and only exceptionally good sires could bring about further improvement.

3. The demonstration showed clearly that breeding is a dominant factor in the production of high-quality beeves and that good feeding and management will not return best results unless the element of good breeding is also present.

As evidence that horses of high merit may be produced through grading up, it is interesting to note that the champion draft gelding at the Chicago International in 1921 and again in 1923, Major MacFarlane, was a grade horse only two generations removed from a Cayuse or Indian Pony mare. This fact should also inspire purebred breeders to still further improvement, if the use of purebred sires is to continue to bring about improvement in grading up the commercial herds.

After some experience, the commercial producer who has successfully handled grade animals may add a few purebreds to the herd and gradually build into the latter, provided that his experience and his market for seed stock justifies this type of production.

Purebreeding

A purebred animal may be defined as a member of a breed, the animals of which possess a common ancestry and distinctive characteristics; and he is either registered or eligible for registry in the herd book of that breed. The breed association consists of a group of breeders banded together for the purpose of: (1) recording the lineage of their animals, (2) protecting the purity of the breed, and (3) promoting the interest of the breed.

It must be emphasized that pure breeding and homozygosity may bear very different connotations. The term "purebred" refers to animals whose entire lineage, regardless of the number of generations removed, traces back to the foundation animals accepted by the breed or to any animals which have been subsequently approved for infusion. On the other hand, homozygosity refers to the likeness of the genes.

Yet there is some interrelationship between purebreds and homozygosity. Because most breeds had a relatively small number of foundation animals, the unavoidable inbreeding and linebreeding during the formative stage resulted in a certain amount of homozygosity. Moreover, through the normal sequence of events, it is estimated that purebreds become more homozygous by from ¼ to ½ per cent per animal generation. It should be emphasized that the word purebred does not necessarily guarantee superior type or high productivity. That is to say, the word purebred is not, within itself, magic, nor is it sacred. Many a person has found to his sorrow that there are such things as "purebred scrubs." Yet, on the average, purebred animals are superior to nonpurebreds.

For the man with experience and adequate capital, the breeding of purebreds may offer unlimited opportunities. It has been well said that honor, fame, and fortune are all within the realm of possible realization of the purebred breeder; but it should also be added that only a few achieve this high calling.

Purebred breeding is a highly specialized type of production. Generally speaking, only the experienced breeder should undertake the production of purebreds with the intention of furnishing foundation or replacement stock to other purebred breeders or purebred bulls to the producer of grades. Although we have had many constructive cattle breeders and great progress has been made, it must be remembered that only a few achieve sufficient success to classify as master breeders.

Inbreeding or Closebreeding

Inbreeding or closebreeding is rarely practiced among present-day stockmen, though it was common in the foundation animals of most of the breeds. For example, it is interesting to note that Comet (155), an illustrious sire and noted as the first Shorthorn to sell for $5,000, came from the mating of Favorite and Young Phoenix, a heifer that had been produced from the union of Favorite with his own dam. Such was the program of the Collings Brothers and many another early-day beef cattle breeder, including those in all breeds.

Inbreeding or closebreeding is that system of breeding in which closely related animals are mated. This includes the mating of: (1) sire to daughter, (2) son to dam, and (3) brother to sister and the minimum number of different ancestors. In the repeated mating of a brother with his full sister, there are only two grandparents instead of four, only

two great-grandparents instead of eight, and only two different ancestors in each generation farther back—instead of the theoretically possible 16, 32, 64, 128, etc. In certain plants, self-fertilization still more rapidly reduces the number of different ancestors, but none of the domestic animals are self-fertilized.

The reasons for practicing inbreeding or closebreeding are:

1. It increases the degree of homozygosity within animals, making the resulting offspring pure or homozygous in a larger proportion of their gene pairs than in the case of linebred or outcross animals. In so doing, the less desirable recessive genes are brought to light so that they can be more readily culled. Thus, inbreeding, together with rigid culling, affords the surest and quickest method of fixing and perpetuating a desirable character or group of characters.

2. If carried on for a period of time, it tends to create lines or strains of animals that are uniform in type and other characteristics.

3. It keeps the relationship to a desirable ancestor highest.

4. Because of the greater homozygosity, it makes for greater prepotency. That is, selected inbred animals are more homozygous for desirable genes (genes which are often dominant), and they, therefore, transmit these genes with greater uniformity.

5. Through the production of inbred lines or families by inbreeding and the subsequent crossing of certain of these lines, it affords a modern approach to livestock improvement. Moreover, the best of the inbred animals are likely to give superior results in outcrosses.

6. Where a breeder is in the unique position of having his herd so far advanced that to go on the outside for seed stock would merely be a step backward, it offers the only sound alternative for maintaining existing quality or making further improvement.

The precautions in inbreeding may be summarized as follows:

1. As inbreeding greatly enhances the chances that recessives will appear during the early generations in obtaining homozygosity, it is almost certain to increase the proportion of worthless breeding stock produced. This may include such so-called "degenerations" as reduction in size, fertility, and general vigor. Lethals and other genetic abnormalities often appear with increased frequency in inbred animals

2. Because of the rigid culling necessary in order to avoid the "fixing" of undesirable characters, especially in the first generations of an inbreeding program, it is almost imperative that this system of breeding be confined to a relatively large herd or flock and to instances when the owner has sufficient finances to stand the rigid culling that must accompany such a program.

3. It requires skill in making planned matings and rigid selection, thus being most successful when applied by "master breeders."

4. It is not adapted for use by the man with average or below average stock because the very fact that his animals are average means that a goodly share of undesirable genes are present. Inbreeding would merely make the animals more homozygous for undesirable genes and therefore worse.

Judging from outward manifestations alone, it might appear that inbreeding is predominantly harmful in its effects—often leading to the production of defective animals lacking in the vitality necessary for successful and profitable production. But this is by no means the whole story. Although inbreeding often leads to the production of animals of low value, the resulting superior animals can confidently be expected to be homozygous for a greater than average number of good genes and thus more valuable for breeding purposes. Figuratively speaking, therefore, inbreeding may be referred to as "trial by fire," and the breeder who practices it can expect to obtain many animals that fail to measure up and have to be culled. On the other hand, if inbreeding is properly handled, he can also expect to secure animals of exceptional value.

Although inbreeding has been practiced less during the past century than in the formative period of the different pure breeds of livestock, it has real merit when its principles and limitations are fully understood. Perhaps inbreeding or closebreeding had best be confined to use by the skilled master breeder who is in a sufficiently sound financial position to endure rigid and intelligent culling and delayed returns and whose herd is both large and above average in quality.

Linebreeding

From a biological standpoint, inbreeding and linebreeding are the same thing, differing merely in intensity. In general, inbreeding has been frowned upon by stockmen, but linebreeding (the less intensive form) has been looked upon with favor in many quarters.

Linebreeding is that system of breeding in which the degree of relationship is less intense than in inbreeding, and in which the matings are usually directed toward keeping the offspring closely related to some highly admired ancestor. In a line-breeding program, therefore, the degree of relationship is not closer than half-brother and half-sister or matings more distantly related; cousin matings, grandparent to grand offspring, etc.



Fig. 27. Prince Domino 499611, calved September 13, 1914 and died April 4, 1930. Many great Herefords have been produced from linebreeding to this immortal sire. Prince Domino's final resting place at Wyoming Hereford Ranch, Cheyenne, Wyoming, is marked with the following epitaph: "He lived and died and won a lasting name." This is a rare tribute, indeed, to any beast—or man. (Courtesy, The American Hereford Journal.)

Linebreeding is usually practiced in order to conserve and perpetuate the good traits of a certain outstanding sire or dam. Because such descendants are of similar lineage, they have the same general type of germ plasm and therefore exhibit a high degree of uniformity in type and performance. During the past three decades, for example, a great many Hereford herds have been linebred to Prince Domino, that immortal Gudgell and Simpson bred bull who, in the hands of Otto Fulscher and the Wyoming Hereford Ranch, contributed so much to the improvement of the Hereford breed. The following great and deserved

tribute marks the final resting place of this bull at Wyoming Hereford Ranch, where he spent his last days in quiet and leisure: "He lived and died and won a lasting name."

In a more limited way, a linebreeding program has the same advantages and disadvantages of an inbreeding program. Stated differently, linebreeding offers fewer possibilities both for good and harm than inbreeding. It is a more conservative and safer type of program, offering less probability to either "hit the jackpot" or "sink the ship." It is a "middle-of-the-road program" that the vast majority of average and small breeders can safely follow to their advantage. Through it, reasonable progress can be made without taking any great risk. A greater degree of homozygosity of certain desirable genes can be secured without running too great a risk of intensifying undesirable ones.

Usually a linebreeding program is best accomplished through breeding to an outstanding sire rather than to an outstanding dam because of the greater number of offspring of the former. If a breeder found himself in possession of a great bull—proved great by the performance records of a large number of his get—a linebreeding program might be initiated in the following way: Select two of the best sons of the noted bull and mate them to their half-sisters, balancing all possible defects in the subsequent matings. The next generation matings might well consist of breeding the daughters of one of the bulls to the son of the other, etc. If, in such a program, it seems wise to secure some outside blood (genes) to correct a common defect or defects in the herd, this may be done through selecting one or more outstanding proved cows from the outside—animals whose get are strong where the herd may be deficient—and then mating this female or females to one of the linebred bulls with the hope of producing a son that may be used in the herd.

The owner of a small purebred herd or flock with limited numbers can often follow a linebreeding program by buying all of his sires from a large breeder who follows such a program—thus in effect following the linebreeding program of the larger breeder.

Naturally, a linebreeding program may be achieved in other ways. Regardless of the actual matings used, the main objective in such a system of breeding is that of rendering the animals homozygous—in desired type and performance—to some great and highly regarded ancestor, while at the same time

weeding out homozygous undesirable characteristics. The success of the program, therefore, is dependent upon: having desirable genes with which to start and an intelligent intensification of these good genes.

It should be emphasized that there are some types of herds that should almost never inbreed or linebreed. These include grade or commercial herds and purebred herds of only average quality.

The owner of a grade or commercial herd runs the risk of undesirable results, and even if successful as a commercial breeder, he cannot sell his stock at increased prices for breeding purposes.

With purebred herds of only average quality, more rapid progress can usually be made by introducing superior outcross sires. Moreover, if the animals are of only average quality they must have a preponderance of "bad" genes that would only be intensified through an inbreeding or linebreeding program.

Outcrossing

Outcrossing is the mating of animals that are members of the same breed but which show no relationship close up in the pedigree (for at least the first four or six generations).

Most of our purebred animals of all classes of livestock are the result of outcrossing. It is a relatively safe system of breeding, for it is unlikely that two such unrelated animals will carry the same "undesirable" genes and pass them on to their offspring.

Perhaps it might well be added that the majority of purebred breeders with average or below average herds had best follow an outcrossing program, because, in such herds, the problem is that of retaining a heterozygous type of germ plasm with the hope that genes for undesirable characters will be counteracted by genes for desirable characters. With such average or below average herds, an inbreeding program would merely make the animals homozygous for the less desirable characters, the presence of which already makes for their mediocrity. In general, continued outcrossing offers neither the hope for improvement nor the hazard of retrogression of a linebreeding or inbreeding program.

Judicious and occasional outcrossing may well be an integral part of linebreeding or inbreeding programs. As closely inbred animals become increasingly homozygous with germ plasm for good characters, they may likewise become homozygous for

certain undesirable characters even though their general overall type and performance remains well above the breed average. Such defects may best be remedied by introducing an outcross through an animal or animals known to be especially strong in the character or characters needing strengthening. This having been accomplished, the wise breeder will return to the original inbreeding or linebreeding program, realizing full well the limitations of an outcrossing program.

Crossbreeding

Crossbreeding is the mating of two animals both of which are purebreds but members of different breeds. In a broad sense, crossbreeding also includes the mating of purebred sires of one breed with high grade females of another breed.

No other system of breeding has been the object of more present-day controversy than crossbreeding. Perhaps, in the final analysis, however, all would agree that *any merits that crossbreeding may possess are and will continue to be based on improved "seed stock."* Certainly, from a genetic standpoint, it should be noted that crossbred animals generally possess greater heterozygosity than outcross animals—perhaps with the added virtue of hybrid vigor. It may also be added that, as in outcrossing, the recessive and undesirable genes remain hidden in the crossbred animal.

On purely theoretical grounds, it would appear that crossbreeding should result in some increase in vigor because the desirable genes from both breeds would be combined and the undesirable genes from each would tend to be over-shadowed as recessives. That is to say, there has been an inevitable, though small, amount of inbreeding in all purebreds during the period of the last 100 to 150 years. This has been partly intentional and partly due to geographical limitations upon the free exchange of breeding stock from one part of the country to another. As a result of this slight degree of inbreeding, there has been a slow but rather constant increase in homozygosis within each of the pure breeds of livestock. Most of the factors fixed in the homozygous state are desirable; but inevitably some undesirable genes have probably been fixed, resulting in lowered vigor, slower growth rate, less ability to live, etc.

Theoretically, then, crossbreeding should be an aid in relegating these undesirable genes to a recessive position and in allowing more dominant genes to express themselves. Practical

observation and limited experiments would indicate that this does occur in crossbreeding.

Crossbreeding programs usually consist of two types: (1) the maintenance of purebred females that are mated to a purebred sire of a different breed and (2) the maintenance of crossbred females generation after generation, with matings to purebred sires of different breeds being on a rotation basis.

In the first system, the producer is sooner or later faced with the problem of breeding the females back to a purebred sire of the same breed in order to get the necessary replacement females to take the place of those lost through old age, injury, lower productivity, death, etc. As can be readily seen, this system allows for a very limited opportunity to build up the quality of the female herd. In the second system, the rotation of sires is often a difficult problem, and the producer will almost inevitably end up with a motley collection of females and progeny varying in type and color. Even though such motley animals may individually be superior, when sold they are very likely to be penalized because of their lack of uniformity in type and color. With many producers, this lack of uniformity also detracts much from the art and the challenge of animal breeding.

This discussion does not preclude the undeniable and proved value of crossbreeding in the creation of new breeds especially adapted to certain conditions. The Santa Gertrudis breed of cattle, a breed derived from five-eights Shorthorn and three-eighths Brahman breeding, was developed to meet a need in the hot, dry and insect-infested area of the Southwest. Experienced cattlemen of the area will vouch for the fact that this is a practical example of a planned system of crossbreeding which has high utility value under the environmental conditions common to the country. Also, the Columbia breed of sheep, representing a Lincoln-Rambouillet cross, is especially well adapted to the better ranges of the West. Still other examples of crossbreeding in the creation of breeds may be cited.

In summary, it can be said that, under certain conditions crossbreeding may have a place, particularly from the standpoint of increased vigor, growth rate, and efficiency of production; but pure breeding will continue to control the destiny of further improvement in any class of livestock and furnish the desired homozygosity and uniformity which many stockmen insist is a part of the art of breeding better livestock.

THE RELATIVE IMPORTANCE OF THE SIRE AND THE DAM

As a sire can have so many more offspring during a given season or a lifetime than a dam, he is from a hereditary standpoint a more important individual than any one female so far as the whole herd is concerned, although both the sire and the dam are of equal importance so far as concerns any one offspring. Because of their wider use, therefore, sires are usually culled more rigidly than females, and the breeder can well afford to pay more for an outstanding sire than for an equally outstanding female.

Experienced stockmen have long felt that sires often more closely resemble their daughters than their sons, whereas dams resemble their sons. Some sires and dams, therefore, enjoy a reputation based almost exclusively on the merit of their sons, whereas others owe their prestige to their daughters. Although this situation is likely to be exaggerated, any such phenomenon that may exist is due to sex-linked inheritance which may be explained as follows: The genes that determine sex are carried on one of the chromosomes. The other genes that are located on the same chromosome will be linked or associated with sex and will be transmitted to the next generation in combination with sex. Thus, because of sex linkage, there are more color-blind men than color-blind women. In poultry breeding, the sex-linked factor may be used in a practical way for the purpose of distinguishing the pullets from the cockerels early in life, through the process known as "sexing" the chicks. When a black cock is crossed with barred hens, all the cocks come barred and all the hens come black. It should be emphasized, however, that under most conditions it appears that the influence of the sire and dam on any one offspring is about equal. Most breeders, therefore, will do well to seek excellence in both sexes of breeding animals.

PREPOTENCY

Prepotency refers to the ability of the animal, either male or female, to stamp its own characteristics on its offspring. The offspring of a prepotent bull, for example, resemble both their sire and each other more closely than usual. The only conclusive and final test of prepotency consists of the inspection of the get.

From a genetic standpoint, there are two requisites that an animal must possess in order to be prepotent: (1) dominance and

(2) homozygosity. Every offspring that receives a dominant gene or genes will show the effect of that gene or genes in the particular character or characters which result therefrom. Moreover, a perfectly homozygous animal would transmit the same kind of genes to all of its offspring. Although entirely homozygous animals probably never exist, it is realized that a system of inbreeding is the only way to produce animals that are as nearly homozygous as possible.

Popular beliefs to the contrary, there is no evidence that prepotency can be predicted by the appearance of an animal. To be more specific, there is no reason why a vigorous, masculine-appearing sire will be any more prepotent than one less desirable in these respects.

It should also be emphasized that it is impossible to determine just how important prepotency may be in animal breeding, although many sires of the past have enjoyed a reputation of being extremely prepotent. Perhaps these animals were prepotent, but there is also the possibility that their reputation for producing outstanding animals may have rested upon the fact that they were mated to some of the best females of the breed.

In summary, it may be said that if a given sire or dam possesses a great number of genes that are completely dominant for desirable type and performance and if the animal is relatively homozygous, the offspring will closely resemble the parent and resemble each other, or be uniform. Fortunate, indeed, is the breeder who possesses such an animal.

NICKING

If the offspring of certain matings are especially outstanding and in general better than their parents, breeders are prone to say that the animals "nicked" well. For example, a cow may produce outstanding calves to the service of a certain bull, but when mated to another bull of apparent equal merit as a sire, the offspring may be disappointing. Or sometimes the mating of a rather average bull to an equally average cow will result in the production of a most outstanding individual both from the standpoint of type and performance.

So-called successful "nicking" is due, genetically speaking, to the fact that the right combination of genes for good characters are contributed by each parent, although each of the parents within itself may be lacking in certain genes necessary for excellence. In other words, the animals "nicked" well because they

respective combinations of good genes were such as to complement each other.

The history of animal breeding includes records of several supposedly favorable "nicks," one of the most famous of which is the favorable result secured from crossing sons of Anxiety 4th with daughters of North Pole in the Gudgell and Simpson herd of Hereford cattle. At this late date, it is impossible to determine whether these Anxiety 4th-North Pole matings were successful because of "nicking" or whether the good results should be



Fig. 28. Anxiety 4th 9904, whose sons were alleged to "nick" exceedingly well on the daughters of North Pole in the Gudgell and Simpson herd of Hereford cattle. (Courtesy, The American Hereford Journal.)

more rightfully attributed to the fact that the sons of Anxiety 4th were great breeding bulls and that they merely happened to be mated, for the most part, with daughters of North Pole because the available females in the Gudgell and Simpson herd were of this particular breeding.

Because of the very nature of successful "nicks," outstanding animals arising therefrom must be carefully scrutinized from a breeding standpoint, because, with their heterozygous origin, it is quite unlikely that they will breed true.

BREED REGISTRY ASSOCIATIONS

The typical history of the formation of the various breeds of livestock may be summarized as follows:

1. A recognition of the existence of what was considered to be a more desirable and useful type.

2. The best animals of that type were gathered into one or a few herds which ceased to introduce outside blood.

3. Intense inbreeding to fix characters followed.

4. With greater numbers of animals, more herds were established.

5. When the breed became so numerous and the number of animal generations in the pedigrees increased until no man could remember all of the foundation animals far back in the pedigree, the necessity for a herd book arose. In addition to supplying knowledge of foundation animals, the herd books were designed to prevent, insofar as possible, unscrupulous traders from exporting grades or common stock as purebreds.

6. The breed associations or societies that published the stud book were also organized for the purposes of: improving the breed and promoting the general interests of the breeders.

Naturally, not all breed histories were identical. Circumstances often varied the pattern that molded the breed, but the end results and objectives were similar. The first herd book of any breed or class of animals, known as "An Introduction to the General Stud Book," published in 1791, was for Thoroughbred horses. In it were included the pedigrees of horses winning the important races. Thus it was really a record of performance. The Shorthorn herd book, first undertaken as the private venture of Mr. George Coates, followed in 1822. Other societies and herd books for the various breeds were originated in due time.

It is interesting to note that some of the early breeders objected to furnishing pedigrees of their sale animals, fearing that they would thus give away valuable trade secrets.

FAMILY NAMES

In cattle, depending upon the breed, family names are traced through either the males or females. In Aberdeen-Angus and Shorthorn cattle, the family names had their origin with certain great foundation females, whereas in Herefords the family names trace through the sires. Similar family names exist in horses, but in both hogs and sheep less importance is attached to them.

Unfortunately, the value of family names is generally grossly exaggerated. Obviously, if the foundation male or female, as the case may be, is very many generations removed, the genetic superiority of this head of a family is halved so many times by subsequent matings that there is little reason to think that one

family is superior to another. The situation is often further distorted by breeders placing a premium on family names of which there are few members, little realizing that, in at least some cases, there may be unfortunate reasons for the scarcity in numbers.

Such family names have about as much significance as human family names. Who would be so foolish as to think that the Joneses as a group are alike and different from the Smiths? Perhaps, if the truth were known, there have been many individuals with each of these family names who have been of no particular credit to the clan, and the same applies to all other family names.

Family names lend themselves readily to speculation. Because of this, the history of livestock breeding has often been blighted by instances of unwise pedigree selection on the basis of not too meaningful family names. The most classical example of a situation of this type occurred with the Duchess family of Shorthorn cattle, founded by the noted pioneer English Shorthorn breeder, Thomas Bates. Bates, and more especially those later breeders who emulated him, followed preferences in bloodlines within increasingly narrow limits, until ultimately they were breeding cattle solely according to fashionable pedigrees, using good, bad, and indifferent animals. Fad and fancy in pedigrees dominated the situation, and the fundamental importance of good individuality as the basis of selecting animals for breeding purposes was for the time largely ignored. The sole desire of these breeders was to concentrate the Duchess blood. The climax of the "Duchess boom" (or "Bates Boom") came in September, 1873, when the New York Mills herd was sold at auction with English and American breeders competing for the offering. At this memorable event, 109 head of Duchess-bred cattle averaged $3,504 per head, with the seven-year-old 8th Duchess of Geneva selling at the world's record price of $40,600.

As with most booms, the New York Mills sale was followed by a rather critical reaction, and eventually the bottom dropped out of values. Even more tragic, the owners of Duchess Shorthorns suddenly came to a realization that indiscriminate inbreeding and a lack of selection had put the family name in disrepute. As a result, the strain became virtually extinct a few years later.

On the other hand, certain linebred families—linebred to a foundation sire or dam so that the family is kept highly related

to it—do have genetic significance. Moreover, if the programs involved have been accompanied by rigid culling, many good individuals may have evolved, and the family name may be in good repute. The Anxiety 4th family of Hereford cattle is probably the best-known family of this kind in meat animals. Even so, there is real danger in assuming that an "airtight" or "straightbred" Anxiety 4th pedigree is within itself meritorious and that this family is superior to that of any other family in Hereford cattle.

SELECTION FOR SEVERAL CHARACTERS

Sometimes stockmen have been burdened by attempting to select for too many characters. For example, horsemen may select for speed, beauty, temperament, size, color, etc. It must be remembered, however, that selection for two or more characteristics automatically cuts down the effectiveness of selection for any one of them. Thus the breeder who selects with equal intensity for type and speed is likely to be left in the position of the dog that chased two rabbits and caught neither. A realization of this fact, together with the fact that in many cases such things as type and beauty are correlated only slightly with productivity, if at all, is undoubtedly behind the current emphasis on production testing with all classes of animals.

SELECTION BASED ON PRODUCTION TESTING

Regardless of whether the present-day purebred breeder is using the old method of mating the best females with the most desirable sires in attempting to improve the productivity of his herd or whether he is attempting to attain homozygosity more rapidly through the genetically more powerful tools of linebreeding and inbreeding, selection of breeding stock on the basis of production records is the next logical procedure. It should be emphasized that this involves the taking of accurate records rather than casual observation. Moreover, in order to be most effective, selection must be based on characteristics of economic importance (rather than breed fancy points), and an objective measure or "yardstick" must be placed upon each of the characteristics that are to be measured. Finally, those breeding animals whose progeny fail to meet the high standards set forth must be removed from the herd promptly and unflinchingly.

As most characters of economic importance—for example, body type and efficiency of feed utilization—are due to many

genes, a method of measuring and selecting for these characters must be devised. Selection based on appearances does not do this, failing to get down to the root of the matter—the genes. Instead, it deals with body form, and the latter may be very misleading. In the following discussion, sheep will be used as an example, though the same principles apply to all classes of farm animals.

The measurement of the performance of any individual sheep—his own weaning weight, type, and finish at weaning time, fleece weight and quality, etc., as determined under standard conditions——is known as *individual merit testing*[1] (sometimes called performance testing); whereas when a ram or ewe is evaluated on the basis of its get—the offspring's weaning weight, fleece weight, staple length, etc., as determined under standard conditions—the system is known as *progeny testing*.[1] Of the two systems, the latter is the most infallible. If a ram has been proved—through the uniformly outstanding quality of his get—one need not be greatly concerned over what he looks like, how he performs, or what is back of him. If the ewe has also been proved, so much the better. Otherwise, it is desirable to ascertain that the female is sired by a good proved sire and from a good ewe family.

On the other hand, if there is progress (with the progeny slightly better on the average than the parents), the individual merit testing of a ram and ewe—meaning their own production record—may be more valuable than their breeding record as determined through progeny testing. This is true because:

1. Their own records are available at an earlier age.
2. It is difficult to apply progeny testing to females because of the relatively few offspring.
3. Progeny testing often does little more than confirm what is already known from individual merit tests.
4. Progeny-testing records are available only after most of the effective selection has already been done.
5. It is usually impractical to progeny test enough rams and ewes so that selection can be effectively practiced among them.
6. When animals are highly selected before progeny testing, the tests will probably not reveal significant differences between them unless large numbers of offspring are obtained.

[1] *Production testing* is a more inclusive term, including progeny testing and/or individual merit testing.

7. There is the hazard that the male being tested will only be bred to a few select females and that only the top offspring will be tested.

8. A regular practice of progeny testing will increase the length of generation, which reduces the rate of progress. Naturally, this is more important with cattle and horses than with hogs or sheep. For example, beef bulls are usually three to four years of age and dairy bulls six to seven years of age before a progeny test can be secured.

For these reasons, when a flock is showing steady improvement, it may be best to select the most promising breeding animals as determined by individual merit testing rather than be delayed by progeny testing.

In individual merit-testing and progeny-testing programs, it must be realized that training and feeding play a major role in producing outstanding animals, making it difficult to separate out environmental from hereditary influences. For greatest effectiveness and progress, therefore, the conditions under which the tests are made should be standardized as much as possible from year to year.

Despite all the difficulties enumerated, and the admitted fact that much more research work is needed in the testing of meat animals, there is ample evidence to indicate that selection on the basis of either individual merit testing or progeny testing is imperative if breed improvement is to take place at the maximum rate. To select intelligently on the basis of a testing program, the breeder must have adequate records and use them.

Production Testing Not New

Progeny testing is not new. It was advocated by the Roman, Varro, two thousand years ago, and it was effectively used by Robert Bakewell in the eighteenth century in his practice of bull and ram letting.

The breeders of race horses have always followed a program of mating animals of proved performance on the track. It is interesting to note that the first breed register, which appeared in 1791 recorded the pedigrees of all the Thoroughbred horses winning important races. In a similar way, the Standardbred horse, which is an American creation, takes its name from the fact that, in its early history, animals were required to trot a mile in two minutes and thirty seconds or pace a mile in two minutes and twenty-five seconds before they could be considered as eligible for registry. The chief aim, therefore, of the early-

day breeders of race horses was to record the pedigrees of outstanding performers rather than all members of the breed.

Milk production has long been used as a criterion for selecting dairy cattle, and with the invention of the Babcock test in 1890, butterfat content also became a measuring device. In the latter part of the nineteenth century, the Holstein-Friesian Breed Association introduced official weighing of milk and testing for butterfat per cent as a part of its program. Now all the major dairy breeds have their "Advanced Registries," designed to give special recognition to outstanding producers. Moreover, Dairy Herd Improvement Associations are in existence throughout the dairy sections of the United States. These associations lend assistance to dairymen in keeping production records of each cow. Production testing in dairy cattle is now the most widely known record of performance used in the United States. Even so, the tragic truth is that actual production records are available on only 5 to 7 per cent of the dairy animals of the United States.

The invention of the trap nest shortly before 1900 made it possible to keep individual egg-production records on hens. Advanced registry for poultry is limited to outstanding producers, and it is doubtful if general registration of all eligible birds will be attempted because of their short life and their comparatively small individual value. Production contests are held annually in which a performance record is based on the production of thirteen purebred pullets for a period of one year. These laying contests have gained increasing favor, and now it seems likely that "Production Shows" are destined to replace "Standard of Perfection Shows" based on conformation and fancy points. No doubt, the tremendous improvement in average egg production in the United States during the past fifty years can, in large part, be attributed to production records (trap-nest records) in the breeding flocks.

Production Testing In Meat Animals More Difficult

Unfortunately, the problem of using production records in meat animals is more difficult than in the classes of animals just mentioned; for no single yardstick or criterion accurately evaluates the worth of an animal. For example, breeders of dairy cattle have measured the milk and butterfat production of the animals; breeders of race horses have used speed as the criterion; and poultry breeders have used egg production. With sheep, beef cattle, and swine, it is more difficult to place a "yard-

stick" upon the characteristics that should be measured. On the other hand, extensive studies have been made of the factors that should be evaluated in breeding meat animals, and today we have a fairly clear idea of the things which should be considered, although the relative importance of each factor is not known. Perhaps the relative importance varies under different conditions. In a discriminating market, quality of product may be the most important factor influencing profitability, whereas under market conditions in which a premium is not paid for quality, economy of production is the most important. Perhaps all would agree that the most profitable type of meat animal over a period of years is the one that most efficiently produces (at the lowest cost) the quantity and quality of carcass which brings the most money over the block.

The Danish System of Production Testing Swine

Without doubt, the outstanding example of record of performance work with fat stock is the swine breeding work of Denmark. This work was started in 1907, and since then, it has operated continuously, except for three years during World War I when shortage of feed forced the suspension of all testing. In the Danish system, the registration of swine is supervised



Fig. 29. Interior view of the world's first swine progeny testing station established in 1907 at "Elsesminde," Denmark. In Denmark four pigs of each litter are tested under standard conditions, with evaluation based on (1) rate and economy of gain and (2) carcass quality at two hundred pounds weight. The most outstanding example in the world of progeny testing meat animals is, without doubt, the swine breeding work of Denmark. (Courtesy, Danish Embassy.)

by a national committee in charge of swine breeding. Only animals bred at organized swine-breeding centers are eligible for registration, because these are the farms where the breeders have complied with certain regulations, including sending each year to the testing stations half as many litters as they have sows in their herd. At the testing stations, these test litters of four pigs each are fed under standard conditions, and the rates and economy of gain are recorded. When each pig reaches a weight of two hundred pounds, it is slaughtered at a nearby bacon factory, and its dressing percentage and the type, conformation, and quality of its carcass are measured and scored. Twice annually, each breeding center is inspected by a committee that scores it for: (1) management and general appearance of the farm, (2) conformation of breeding animals, (3) fertility of the breeding animals, (4) efficiency in the use of feed by the test pigs from this center, and (5) slaughter quality of the test pigs. The advances made in the carcass qualities (body length, belly and backfat thickness), plus efficiency of feed utilization, have been phenomenal. Swine selection in Denmark is strictly based on utility considerations.

General Considerations In Production Testing

The "yardsticks" or criteria used in testing will vary somewhat with the class of farm animals. For example, in sheep, both wool and lamb production are important; and with both sheep and swine, multiple births are a major factor. A detailed discussion of the production records applicable to each species will be given in the breeding section devoted to each class of farm animals.

A prerequisite for any testing data, regardless of species, is that each animal be positively identified—by means of ear notches, ear tags, or tattoos. With purebred breeders, who must use a system of animal identification anyway, this is not an additional detail. But the taking of weights and grades does require additional time and labor—an expenditure which is highly worth while, however.

Body-type scores had best be taken at a standard weight or a standard age (at weaning time and perhaps annually thereafter), probably being evaluated in terms of either a numerical score or a letter. It is important that all animals be evaluated and their scores made a part of the permanent record. Consistently good production is to be desired; the hazard being that it is all too easy for a breeder to remember the good individuals

produced by a given animal and to forget those which are mediocre or culls.

Record forms should be relatively simple. Furthermore, they should be in a form that will permit easy summarization—for example, the record of one female should be on one sheet if possible.

Information on the productivity of close relatives (the sire and the dam and the brothers and sisters) can supplement that on the animal itself and thus be a distinct aid in selection. The records of more distant relatives are of little significance, because, individually, due to the sampling nature of inheritance, they contribute only a few genes to an animal many generations removed.

Under practical conditions, testing with meat animals is usually confined to the sire; for a male produces during his lifetime many more offspring than a female. Because of the relatively small numbers of offspring, testing with females (except with litter-bearing sows) is somewhat more difficult, and as a rule, a female cannot be thoroughly progeny tested until she has spent half or more of her lifetime in a herd. Certainly, the intelligent breeder should study his females and cull those which consistently fail to produce good offspring. If possible, the females should also be tested, especially those that may become the dams of future sires.

A good plan in progeny testing young sires consists of retaining and mating one or more—the numbers depending upon the size of the herd—on a limited number of females during their first season of breeding. The progeny are then tested and evaluated, and only those males that have proved to be best on the basis of their progeny are retained for further breeding purposes. Thus, if young bulls eighteen months of age are each mated to eight to twelve females, calves should be born nine months later, and the progeny can be tested between the ages of seven and twelve months. With good fortune, it is possible to have progeny data on a beef bull when he is approximately thirty-nine months of age. With dairy bulls, whose daughters must be in lactation in order to make the test, it is not possible to make an evaluation until the animal is six to seven years of age.

Summary of Production Testing

In summary, it should be pointed out that progressive live-stock breeders are beginning to look for sires backed by records

will start now to get his herd on a tested basis. Even though production testing is one of the keenest tools available to the breeder, for best results one should continue to use all three major methods of selection—individuality, pedigree, and either individual merit or progeny testing—but with increasing emphasis upon one of the latter methods. In other words, *testing should be used to supplement individual and pedigree selection rather than to displace them,* as is sometimes advocated. Individuality tells us what an animal seems to be; his pedigree tells us what he ought to be; but his performance and progeny tell us what he really is.

ARTIFICIAL INSEMINATION

Artificial insemination is, by definition, the deposition of spermatozoa in the female genitalia by artificial rather than by natural means.

Legend has it that artificial insemination had its origin in 1322, at which time an Arab chieftain used artificial methods to impregnate a prized mare with semen stealthily collected by night from the sheath of a stallion belonging to an enemy tribe. There is no substantial evidence, however, to indicate that the Arabs practiced artificial insemination to any appreciable degree.

The first scientific research in artificial insemination of domestic animals was conducted with dogs by the Italian physiologist, Lazarro Spallanzani, in 1780. A century later, American veterinarians employed artificial means to get mares in foal that persistently had failed to settle to natural service. They noticed that because of obstructions the semen was often found in the vagina and not in the uterus following natural service. By collecting the semen into a syringe from the floor of the vagina and injecting it into the uterus, they were able to impregnate mares with these anatomical difficulties.

The Russian physiologist, Ivanoff, began a study of artificial insemination of farm animals, particularly horses, in 1899; and in 1922, he was called upon by the Russian government to apply his findings in an effort to reestablish the livestock industry following its depletion during World War I. Crude as his methods were, his work with horses must be considered the foundation upon which the success of the more recent work is based.

The shifting of the large-scale use of artificial insemination to cattle and sheep, two decades after it was first introduced for horses, was not caused by the fading importance of the horse and

the increased demand for cattle and sheep. Rather, it was found that progress was quicker and more easily achieved with these animals, because the physiological mechanism of reproduction in cattle and sheep is more favorable than in horses. It was also discovered that the sperm of bulls and rams survive better in storage than stallion sperm, and that the reproductive processes in the female of these species are less complicated than in the mare. In more recent years, considerable progress has been made in the treatment of stallion and jack semen, so that at present it can be used for artificial insemination with satisfactory results, under certain conditions and for a limited period of time.



Fig. 30. The inseminator is shown preparing for insemination of a cow. The semen is being drawn into the catheter by means of a syringe. The semen tubes are carried in thermos bottles in an ice chest which aids in maintaining a 40° F. temperature. Other equipment is carried in the box at the right. In the United States, artificial insemination is more widely used with dairy cattle than with any other class of farm animals. (Courtesy, New York Artificial Breeders' Cooperative.)

Following World War II, the British scientists were called upon to make wide use of artificial insemination in reestablishing the livestock industry of England. They looked upon it as: (1) a way in which to increase more rapidly the efficiency and utility value of their animals through making wider use of outstanding sires, (2) a means of controlling certain diseases, and (3) the best way in which to increase breeding efficiency.

Advantages of Artificial Insemination

The advantages of artificial insemination may be listed as follows: (1) The use of outstanding sires may be increased; (2) it lessens the disease hazard; (3) physical handicaps to mating may be overcome; (4) more sires may be proved; (5) it creates large families of animals. Each of these advantages will be discussed separately.

THE USE OF OUTSTANDING SIRES MAY BE INCREASED:

At the present time, livestock owners are primarily interested in artificial breeding as a means of obtaining the maximum service from a very valuable sire or of overcoming difficulty in getting a valuable female to conceive. As to its effectiveness in extending the usefulness of superior sires, it is interesting to note that the Russians report that sheep and cattle were inseminated at a ratio of fifteen thousand ewes to one ram and nine hundred cows to one bull at one of their breeding centers in 1936. It is reported[1] that "Rag Apple," Cornell University's nine-year-old Holstein bull, sired the amazing total of fifteen thousand calves in five years of artificial insemination service.

IT LESSENS THE DISEASE HAZARD:

Artificial insemination may prove to be equally valuable as a means of preventing and controlling the spread of certain types of diseases, especially those associated with the organs of reproduction—such as Dourine (equine syphilis) in horses. However, when improperly practiced, this method of breeding may be an added means of spreading disease. It is most essential that all males used be carefully examined for symptoms of transmissible diseases. Bacterial contamination must be avoided during the collection and storage of semen, and clean, sterile equipment must be used in the insemination.

[1] William G. Schulz, "Goodby Butcher Bulls," *Country Gentleman*, May, 1948, 18.

PHYSICAL HANDICAPS TO MATING MAY BE OVERCOME:

Artificial insemination is often of value in overcoming certain nonheritable physical defects, and it facilitates the mating of animals of greatly different sizes. Very often artificial insemination may be used in order to extend the usefulness of sires that for some reason have become incapable of performing natural service. It may also increase the use of males of monogamous species such as the fox. Artificial insemination also promises to be a useful tool in hybridization experiments.

MORE SIRES MAY BE PROVED:

Because of the small size of the herds in which they are used, many sires are never proved. Still others have been destroyed before their true breeding worth is known. Males that are mated with a great number of females in a given season offer opportunities for predicting their genetic worth that were formerly denied.

IT CREATES LARGE FAMILIES OF ANIMALS:

The use of artificial insemination makes possible the development of large numbers of animals within a superior family, thus providing uniformity and giving a better basis for a constructive breeding program.

Disadvantages of Artificial Insemination

Like many other wonderful techniques, artificial insemination is not without its limitations. A full understanding of such limitations, however, will merely accentuate and extend its usefulness. The possible disadvantages of artificial insemination may be summarized as follows: (1) It must conform to physiological principles; (2) it may increase the spread of disease; (3) the practice has limitations; (4) certain abuses are possible; (5) it may restrict the sire market. Each of these disadvantages or limitations will be discussed separately.

IT MUST CONFORM TO PHYSIOLOGICAL PRINCIPLES:

One would naturally expect that the practice of artificial insemination must conform to certain physiological principles. Unfortunately, much false information concerning the usefulness of artificial insemination has been encountered—for example, the belief that females will conceive if artificially inseminated at any time during the estrual cycle. Others have even accepted exaggerated claims that the quality of semen may be improved through such handling, only to be disappointed.

IT MAY INCREASE THE SPREAD OF DISEASE:

As previously indicated, the careful and intelligent use of artificial insemination will lessen the spread of disease. On the other hand, carelessness or ignorance may result in the rapid spread of disease.

THE PRACTICE HAS LIMITATIONS:

The practice of artificial insemination is subject to limitation because, although the techniques of collecting and introducing the semen have been highly developed, the methods of extending the usefulness of semen for long periods of time need further study. It must also be realized that when a male sires the wrong type of offspring his damage is merely accentuated because of the increased number of progeny possible.

CERTAIN ABUSES ARE POSSIBLE:

If semen is transported from farm to farm, the character of the operator must be above reproach. Trained workers can detect differences in the spermatozoa of the bull, boar, ram, stallion, or cock; but even the most skilled scientist is unable to differentiate between the semen of a Thoroughbred and a Morgan, to say nothing of the differences between two stallions of the same breed.

Of course, with skilled workers performing the techniques required in artificial insemination, there usually is more check on the operations and perhaps less likelihood of dishonesty than when only the owner is involved, such as is usually the situation with natural services.

IT MAY RESTRICT THE SIRE MARKET:

The fact that the market demand for poor or average sires will decrease if artificial insemination is widely adopted should probably be considered as an attribute rather than a disadvantage.

Summary of Artificial Insemination

Artificial insemination finds useful application in large breeding establishments, especially with dairy cattle; but as yet, it has seldom found practical application with other classes of farm animals. Someday it may. The knowledge of the reproductive processes gained from artificial insemination, however, can contribute materially to the increased efficiency of animal production.

In the wild state, when a female was served several times during her heat period, an annual conception rate of 90 to 100 per

cent was common rather than the exception. Aside from frequency of service, the outdoor exercise, vigor, good nutrition, and regular breeding habits and lack of contamination were conducive to conception. On the other hand, when handled under unnatural conditions in confinement, when the female is generally bred as soon as she starts to show signs of heat, it is not surprising that the conception rate rarely ranges from 50 to 80 per cent and is frequently much less. Perhaps, among its virtues, artificial insemination does offer some promise of assuring a higher conception rate.

NEW ANIMAL FRONTIERS THROUGH BREEDING

Many livestock breeders are aware of the phenomenal success that has been attained by inbreeding corn and then producing crossbreds, popularly known as "hybrid corn," which are used commercially. Hybrid corn research, covering a period of thirty years, cost an estimated fifteen million dollars. Yet, it has paid handsome dividends. In 1933, only 0.2 per cent of the maize acreage of the great Corn Belt was planted to hybrid seed, whereas today it is conservatively estimated that 95 per cent of the corn grown in the corn-producing sections of the United States is of hybrid origin. In general, such corn has been found to yield about 10 to 15 per cent higher than the best open-pollinated varieties. It has been estimated that the increased yield from hybrid corn in the one year of 1946 amounted to 750,000,000 bushels, valued at approximately one billion dollars. This amount of corn would be sufficient to produce 3,750,000,000 pounds of beef, or 5,625,000,000 pounds of lamb, or 10,012,500,000 pounds of pork—enough to supply each man, woman and child in the nation with from one-fourth to one-half their annual per capita meat requirement. It has been further estimated that the two billion dollars spent in the development of the atom bomb—the mysterious Manhattan project—was retrieved through the increased yields of hybrid corn alone during the years 1942 to 1945, the period of the atom bomb development.

Purely from a biological standpoint, there appears to be no reason why similar breeding methods to those used in hybrid corn should not bring about equally effective improvement in the quality of commercial livestock. That is, highly inbred strains of hogs, cattle, or sheep could be formed and then the inbred strains crossed for commercial production.

From a practical production standpoint, however, there are several factors that make this breeding system more difficult to follow with animals than with corn. These are as follows:

1. Corn can be self-pollinated and therefore self-fertilized, whereas the closest inbreeding that can be accomplished with livestock is brother-sister matings. From a genetic standpoint, this brings about homozygosis less than one-half as fast as self-fertilization.

2. Corn breeding requires very much less outlay of cash than animal breeding. With corn it is easily possible to start a thousand inbred lines in any one year and maintain them as long as they show desirable characteristics. However, the maintenance of a thousand inbred lines of any class of livestock is quite a different problem.

3. The production of abnormal animals, which is almost inevitable in inbreeding—even if it occurs only to a limited extent—represents a considerable economic loss to the stockman; whereas no such costly economic losses are encountered by the plant breeder.

Even these difficulties, however, do not appear to be insurmountable provided that there is cooperative effort. Thus the problem is being attacked through the regional swine-, sheep-, and cattle-breeding laboratories—each of which represents a huge cooperative venture between the U. S. Department of Agriculture and the several cooperating state Agricultural Experiment Stations. In these laboratories, inbred lines of the respective classes of livestock are being formed with the eventual purpose of: (1) determining whether crosses between them will produce more desirable commercial animals than now available and (2) using them to further improve purebred livestock. This system is what may be described as a modern approach to livestock improvement. At the present time, it is very much in the experimental stage, and it is impossible to predict whether or not the results will be as phenomenal as the production of hybrid corn. Certainly, it is both slower and more costly, and more difficulties must be surmounted. Nevertheless, the stakes are great.

Production-testing techniques are being refined rapidly, with wider and more practical applications inevitable. In addition, it is likely that the introduction and formation of new and better-adapted breeds of livestock will continue to increase. These and other approaches to new frontiers in animal improvement deserve careful exploration.

REFERENCES

Further information relative to breeding as applied to each of the respective classes of livestock is presented in the following books by the same author and the same publisher as *Animal Science:*

Beef Cattle Husbandry

Sheep Husbandry

Swine Husbandry

Horse Husbandry

CHAPTER III

FEEDING LIVESTOCK[1]

Animals inherit certain genetic possibilities, but how well these potentialities develop depends upon the environment to which they are subjected; and the most fundamental influence in the environment is the feed. In turn, all feeds which come directly or indirectly from plants which have their roots in the soil vary in composition according to the soils upon which they are grown. Thus, we have the cycle as a whole—from the soil, through the plant, thence to the animal, and back to the soil again.

Lush pastures and well-cured, dry forages produced on fertile soils, together with a multitude of grains and by-product feeds —many of which are inedible by man—constitute the basis of successful livestock production. In this category are hay, pasture, certain grains, mill feeds, and other by-products which are converted into meat, eggs, milk and wool. Moreover, more than 55 per cent of the land area of the United States is pastured all or part of the year. Much of this forage is produced on lands unsuited for the growth of bread grains or gardens.

As further evidence that the feeding of the various classes of livestock constitutes a major farm enterprise in the United States, it might be pointed out that more than half of the average annual gross farm income is derived from the sale of animals and animal products. It is important, therefore, that feeding practices on the farm be as efficient and economical as possible. To this end, every livestock producer should endeavor to provide a ration that is both satisfactory and inexpensive—a ration

[1]The author gratefully acknowledges the helpful suggestions of the following eminent nutrition specialists who reviewed Chapters III, XIV, XXII, XXXI, and XLIV: Dr. T. J. Cunha, Chairman, Department of Animal Husbandry, University of Florida, Gainesville, Florida; and Dr. R. W. Colby, Nutrition Specialist, Agricultural and Mechanical College of Texas, College Station, Texas.

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which makes for the maximum production of a quality product per unit of feed consumed.

THE FUNCTION OF FEEDS

The feed consumed by animals is used for a number of different purposes, the exact usage varying somewhat with the class, age, and productivity of the animal. With all animals, a certain part of the feed is used for the maintenance of bodily functions aside from any useful production. This is known as the maintenance requirement. In addition, the various classes of ani-

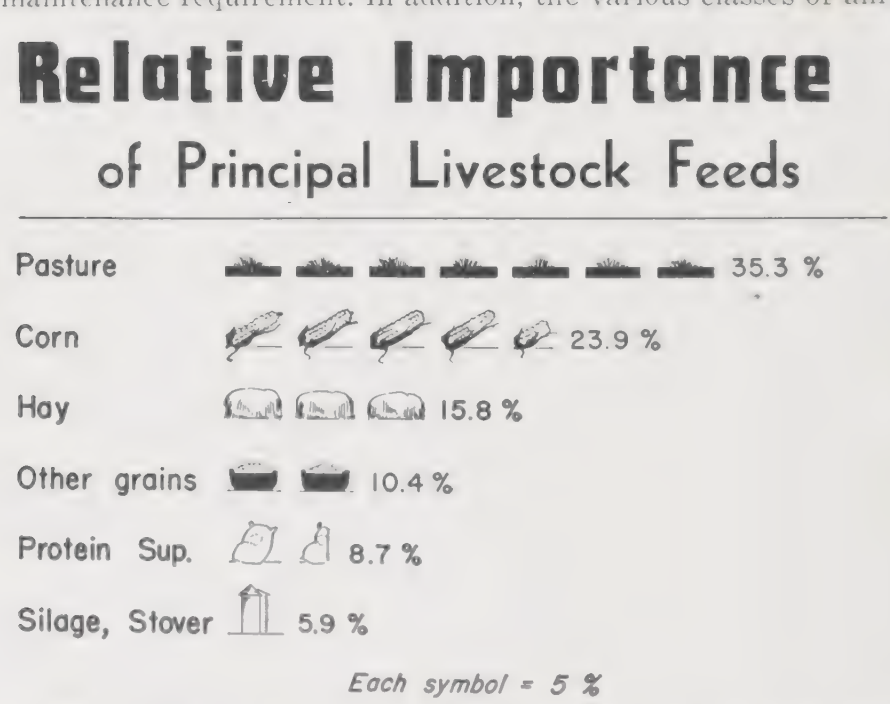


Fig. 31. These principal livestock feeds are converted into meat, eggs, milk and wool. About two-thirds of the feed consumed by animals is not suited for human consumption. (Drawing by R. F. Johnson.)

mals use feed to take care of the functions for which they are kept. Thus, young, growing animals need nutrients suitable for building muscle tissue and bone; fattening animals need a surplus of energy feeds for the formation of fat; breeding females require feed for the development of their fetus and, following parturition, for the production of milk; whereas work (or running) animals use feed to supply energy for productive work. Still other classes of animals require feed for the production of eggs and wool. Each of these needs will be discussed separately.

Maintenance

An animal differs from an engine in that the latter has no fuel requirement when idle; whereas an animal requires fuel every second of the day, whether it is idle or not.

The maintenance requirement may be defined as a ration which is adequate to prevent any loss or gain of tissue in the body when there is no production. Although these requirements are relatively simple, they are essential for life itself. A mature animal must have heat to maintain body temperature, sufficient energy to cover the internal work of the body and the minimum movement of the animal, and a small amount of proteins, vitamins, and minerals for the repair of body tissues.

No matter how quietly an animal may be lying in the stall, it still requires a certain amount of fuel, and the least amount on which it can exist is called its basal maintenance requirement. The animal requires about 15 per cent more fuel when standing than when lying and still more for any movement it may make. This explains why it is desirable for economic reasons that fattening animals should eat and then lie down as much as possible. Even under the best of conditions, about one-half of all the feed consumed by animals is used in meeting the maintenance requirement.

Growth

Growth may be defined as the increase in size of the muscles, bones, internal organs, and other parts of the body. Naturally, the growth requirements become increasingly acute when animals are forced for early usage, such as the training and racing of a two- or three-year-old horse.

Growth has been referred to as the foundation of animal production. Young cattle, sheep, and swine will not make the most economical fattening gains unless they have been raised to be thrifty and vigorous. Likewise, breeding females may have their productive ability seriously impaired if they have been raised improperly. Nor can one expect the most satisfactory yields of milk from dairy cows, unless they have been well developed as heifers. Work horses and mules cannot perform the maximum amount of work, and running horses do not possess the desired speed and endurance, if their growth has been stunted or if their skeletons have been injured by inadequate rations during the growth period.

Fattening (or Show-Ring Fitting)

As the name indicates, fattening is the laying on of fat, especially in the tissues of the abdominal cavity and in the connective tissues just under the skin and between the muscles.

The composition of a ration for fattening alone may be the same as for maintenance, but it must be supplied in larger quantities.

In practical fattening (or fitting) rations, higher condition in mature animals is usually obtained through increasing the allowance of feeds high in carbohydrates and fats—a more liberal allowance of grains. Any surplus of protein may also serve for the production of fat, but usually such feeds are more expensive and are not used for economy reasons. In fattening mature animals, very little more proteins, minerals, and vitamins are required than for maintenance. In fitting young, growing animals, however, it is essential that—in addition to supplying more carbohydrates and fats—ample proteins, minerals, and vitamins be provided.

In general, the more feed a growing or fattening animal consumes, the more economical will be its gains. For example, it may be assumed that a calf requires 6 pounds of feed daily to maintain itself, when making no gain. With an additional 3 pounds of feed, or a daily ration of 9 pounds, it gains 1 pound daily in weight. If the ration is increased by another 3 pounds, bringing the daily allowance to 12 pounds, it gains 2 pounds daily in weight. Thus, each 3 pounds of feed over and above the maintenance requirement (6 pounds per day for maintenance) produced a gain of 1 pound in live weight. On the basis of total feed consumed, however, the first pound of gain required a total of 9 pounds of feed (the first 6 pounds for maintenance and an additional 3 pounds for gain), whereas the next pound of gain only required an additional 3 pounds of feed. The facts, as illustrated in this oversimplified way, are the basis for the statement that for economical fattening the feeder should get every possible ounce of feed "under their hides." The chief difference between good and poor feeders is in the amount of feed above the maintenance requirement that they are able to consume. This also shows why it is necessary to have animals with ample feed capacity.

Reproduction and Lactation

Regular and normal reproduction is the basis for profit on any farm or ranch. Despite this undeniable fact, it has been

estimated that from 20 to 50 per cent of all matings are infertile, that 25 per cent of all cows culled from dairy herds are removed because of reproductive inefficiency, that the overall average United States calf crop of beef cattle is only 63 per cent, that 6 to 10 per cent of all ewes are sterile, that only 40 to 60 per cent of all mares bred actually produce foals, and that 15 to 20 per cent of all sows bred fail to produce litters. Certainly, there are many causes of reproductive failure, but most scientists are agreed that inadequate nutrition is a major one.

With all species, most of the growth of the fetus occurs during the last third of pregnancy, thus making the reproductive requirements most critical during this period. The ration of the pregnant female should supply sufficient amounts of protein, minerals, and vitamins.

With females of all species, the nutritive requirements for moderate to heavy milk production are much more rigorous than the pregnancy requirements. There is special need for a rather liberal protein, mineral, and vitamin allowance.

In the case of young, growing, pregnant females, additional protein, minerals, and vitamins, above the ordinary requirements, must be provided; otherwise, the fetus will not develop properly or milk will be produced at the expense of the tissues of the dam.

It is also known that the ration exerts a powerful effect on sperm production and semen quality. Too fat a condition can even lead to temporary or permanent sterility. Moreover, there is abundant evidence that greater fertility of herd sires exists under conditions where a well-balanced ration and plenty of exercise are provided.

Work (or Running)

In many respects, work requirements are similar to the needs for fattening, both functions requiring high-energy feeds. The function of work (or running) is, for the most part, limited to horses, though in certain parts of the world oxen furnish the chief source of power.

For mature work horses, not in reproduction, work is performed primarily at the expense of the carbohydrates and fats of the ration—energy that can be supplied in the form of additional grain. Theoretically, the protein is not drawn upon so long as the other nutrients are present in adequate amounts. From a practical standpoint, however, it is usually desirable to feed more proteins than the maintenance requirement, merely to insure that the animal can make efficient use of the remainder of

the nutrients in the ration. In other words, when a ration too low in protein is fed, more feed is required because the animal is unable to utilize the ration efficiently. For work animals, the mineral and vitamin requirements are practically the same as for comparable idle animals—except for the greater need for salt because of increased perspiration.

Wool

Wool is a high-protein product. Thus, a shortage of protein in the ration will lessen wool production, even though the total amount of the ration is adequate. It is also known that both the quality and quantity of fiber may be materially lowered if the animals are subjected to unfavorable thrift or health. If such periods are of relatively short duration, tender spots (weak spots) appear in the growth of the fiber.

ESSENTIALS OF AN ADEQUATE RATION

To supply all the needs—maintenance, growth, fattening, reproduction and lactation, work (or running), and wool—the different classes of animals must receive sufficient feed to furnish the necessary quantity of proteins, energy (carbohydrates and fats), minerals, vitamins, and water. Perhaps, under certain conditions, antibiotics may be desirable, although it is not likely that they are essential. These components of an adequate ration will now receive consideration.

Protein Needs

For more than a century, proteins and their structural units, the amino acids, have been studied and recognized as important dietary constituents. Proteins are complex organic compounds made up chiefly of amino acids, which are present in characteristic proportions for each specific protein. This nutrient always contains carbon, hydrogen, oxygen, and nitrogen, and in addition it usually contains sulphur and frequently phosphorus. Proteins are essential in all plant and animal life as components of the active protoplasm of each living cell.

In plants, the protein is largely concentrated in the actively growing portions, especially the leaves and seeds. Plants also have the ability to synthesize their own proteins from such relatively simple soil and air compounds as carbon dioxide, water, nitrates, and sulfates. Thus plants, together with some bacteria which are able to synthesize these products, are the original sources of all proteins.

In animals, proteins are much more widely distributed than in plants. Thus, the proteins of the animal body are primary constituents of many structural and protective tissues—such as bones, ligaments, hair, nails, skin and the soft tissues which include the organs and muscles. The total protein content of animal bodies ranges from about 10 per cent in very fat mature animals to 20 per cent in thin young animals. By way of further contrast, it is also interesting to note that, except for the bacterial action in the rumen, animals lack the ability of the plant

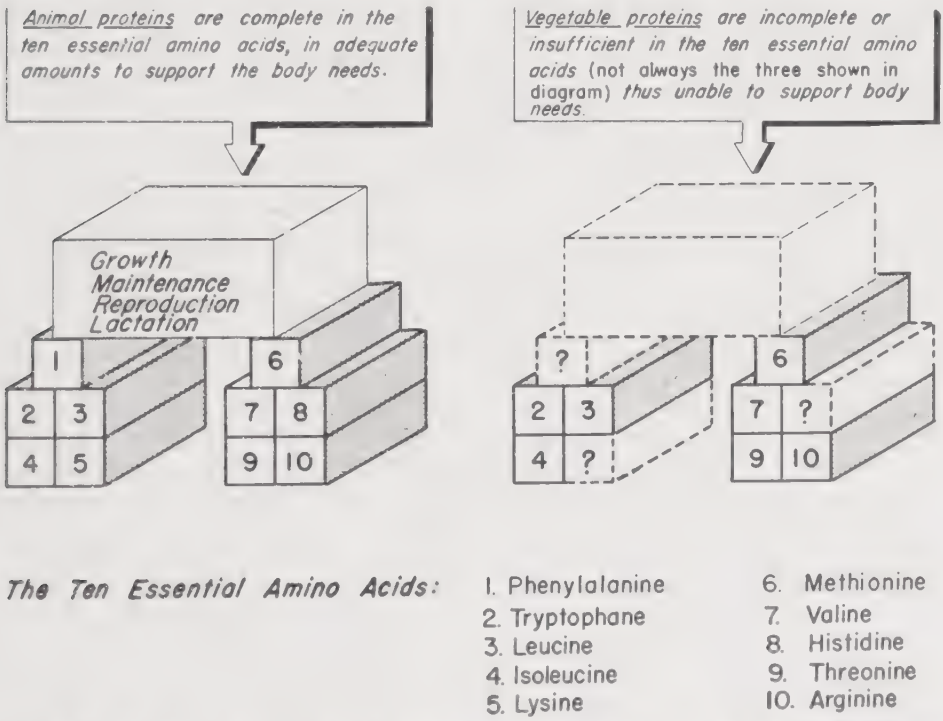


Fig. 32. The amino acids are sometimes referred to as the building stones of proteins. Rations that furnish an insufficient amount of the essential building stones (amino acids) are said to have proteins of poor quality. In general, proteins of animal origin are of good quality, whereas proteins of plant origin are of poor quality. (Drawing by R. F. Johnson.)

to synthesize proteins from simple materials. They must depend upon plants or other animals as a source of dietary protein. In brief, except for the high quality proteins built by the bacterial action in the paunch of ruminants, the animal must have amino acids or more complete protein compounds in their rations.

Animals of all ages and kinds require adequate amounts of protein of suitable quality, this being required for maintenance, growth, fattening, reproduction, work, and wool production. Of course, the protein requirements for growth and reproduction are the greatest and most critical.

QUALITY OF PROTEINS:

In addition to supplying an adequate quantity of proteins, it is essential that the character of proteins be thoroughly understood. Proteins are very complex compounds with each molecule made up of hundreds and thousands of amino acids combined with each other. The amino acids, of which some twenty-three are known, are sometimes referred to as the building stones of proteins. Certain of these amino acids can be made by the animal's body to satisfy its needs. Others cannot be formed fast enough to supply the body's needs and, therefore, are known as essential amino acids. These must be supplied in the feed. Thus, rations that furnish an insufficient amount of any of the essential amino acids are said to have proteins of poor quality, whereas those which provide the proper proportions of the various necessary amino acids are said to supply proteins of good quality. In general, proteins of plant origin (linseed meal, cottonseed meal, soybean meal, and peanut meal) are of poor quality. Proteins of animal origin (meat, fish, eggs, milk, and their by-products) are of good quality.

The necessity of each amino acid in the diet of the experimental rat has been thoroughly tested, but less is known about the requirements of large animals or even the human. According to our present knowledge, based largely on work with the rat, the following division of amino acids as indispensable and dispensable seems proper:

Indispensable	Dispensable
Arginine	Alanine
Histidine	Aspartic acid
Isoleucine	Citrulline
Leucine	Cystine
Lysine	Glutamic acid
Methionine	Glycine
Phenylalanine	Hydroxyglutamic acid
Threonine	Hydroxyproline
Tryptophane	Proline
Valine	Serine
	Tyrosine

Fortunately, the amino-acid content of proteins from various sources varies. Thus, the deficiencies of one protein may be improved by combining it with another, and the mixture of the two proteins often will have a higher feeding value than either one alone. It is for this reason that a considerable variety of feeds in the ration is usually recommended.

The feed proteins are broken down into amino acids by digestion. They are then absorbed and distributed by the blood stream to the body cells, which rebuild these amino acids into body proteins.

RUMEN SYNTHESIS:

In the case of ruminants (cattle and sheep), there is a tremendous bacterial action in the paunch. These bacteria build

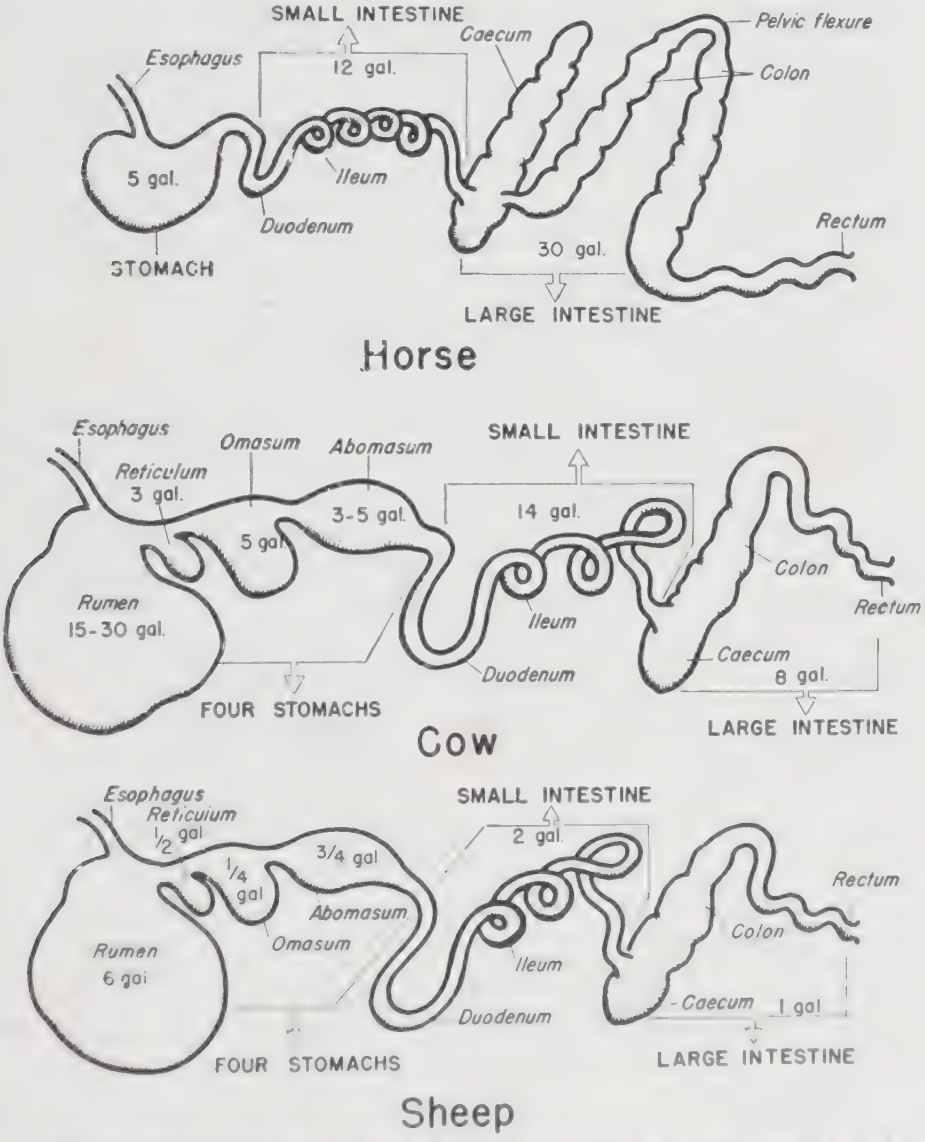


Fig. 33. Schematic diagram of digestive tracts of horse, cow, and sheep. The caecum of the horse and the rumen of the cow and sheep are the seat of tremendous bacterial action through which high quality proteins are synthesized. Because of this arrangement, high quality proteins are not so important in the ration of the horse and ruminants, except in the case of young stock. (Drawing by R. F. Johnson.)

body proteins of high quality from sources of inorganic nitrogen that nonruminants (humans, rats, chickens, swine, poultry, and dogs) cannot use. Farther on in the digestive tract, the ruminant digests the bacteria and secures good proteins therefrom. Although the horse is not a ruminant, apparently the same bacterial process occurs to a more limited extent in the caecum, that greatly enlarged blind pouch of the large intestine of the horse.

In ruminant and horse nutrition, therefore, even such nonprotein sources of combined nitrogen as ammonia and urea have a protein replacement value. In general, meeting the protein requirements of ruminants is not a critical problem insofar as quality is concerned. An exception is the very young ruminant (or horse) in which the rumen (or caecum) and its synthetic ability are not yet well developed. For such an animal, high quality proteins in the diet are requisite to normal development.

PRACTICAL PROTEIN SOURCES:

In practical feeding operations, hogs and chicken should be provided with some protein feeds of animal origin in order to supplement the proteins found in grains and forages. In feeding mature cattle, sheep, and horses, a safe plan to follow is to provide a liberal supply of high-quality legume hay or lush young pasture along with the concentrates. Also, as previously indicated, the quality of the proteins in the ration is likely to be higher if a variety of feeds are combined.

In general, feeds of high protein content are more expensive than those high in carbohydrates or fats. Accordingly, there is a temptation to feed too little of the proteins. On the other hand, when protein feeds are the cheapest—as is often true of cull peas in certain sections of the West and of cottonseed meal in the South—excess quantities of them may be fed as energy feeds without harm, provided that the ration is balanced out in all other respects. Any amino acids that are left over, after the protein requirements have been met, are deaminated or broken down in the body. In this process, a part of each amino acid is turned into energy, and the remainder is excreted via the kidneys.

Energy Needs

It is common knowledge that a ration must contain proteins, fats, and carbohydrates. Although each of these has specific functions in maintaining a normal body, they can all be used to provide energy for maintenance, for work, or for fattening

From the standpoint of supplying the normal energy needs of both humans and animals, however, the carbohydrates are by far the most important, more of them being consumed than any other compound, whereas the fats are next in importance for energy purposes. Carbohydrates are usually more abundant and cheaper, and they are very easily digested, absorbed, and transformed into body fat. Also, carbohydrate feeds may be more easily stored in warm weather and for longer periods of time. Feeds high in fat content are likely to become rancid, and rancid feed is unpalatable, if not actually injurious in some instances.

CARBOHYDRATES:

The carbohydrates are organic compounds composed of carbon, hydrogen, and oxygen. This group includes the sugars, starch, cellulose, gums, and related substances. They are formed in the plant by photosynthesis as follows: $6CO_2 + 6H_2O +$ energy from sun $= C_6H_{12}O_6$ (glucose) $+ 6O_2$. On the average, the carbohydrates comprise about three-fourths of all the dry matter in plants, the chief source of animal feed. They form the woody framework of plants as well as the chief reserve food stored in seeds, roots, and tubers. When consumed by animals, carbohydrates are used as a source of heat and energy, and any excess of them is stored in the body as fat.

No appreciable amount of carbohydrate is found in the animal body at any one time, the blood supply being held rather constant at about 0.05 to 0.1 per cent for most animals but, with the pig, ranging from 0.05 to 0.25 per cent. However, this small quantity of glucose in the blood, which is constantly replenished by changing the glycogen of the liver back to glucose, serves as the chief source of fuel with which to maintain the body temperature and to furnish the energy needed for all body processes. The storage of glycogen (so-called "animal starch") in the liver amounts to 3 to 7 per cent of the weight of that organ.

CARBOHYDRATE FEEDS CONSIST OF NITROGEN-FREE EXTRACT AND FIBER

From a feeding standpoint, the carbohydrates consist of nitrogen-free extract (N.F.E.) and fiber. The nitrogen-free extract includes the more soluble, and therefore the more digestible, carbohydrates—such as the starches, sugars, hemicelluloses, and the more soluble part of the celluloses and pentosans. The fiber is that woody portion of plants (or feeds) which is not dissolved out by weak acids and alkalies. Fiber, therefore, is less easily digested. It includes cellulose, hemicellulose, and lignin.

Use of Fibrous Roughages Possible Because of Bacterial Action

The ability of animals to utilize roughages, to digest the fiber therein, depends chiefly on bacterial action. It is a true symbiotic type of relationship, carried out chiefly by anaerobic bacteria. This action is confined largely to the first three compartments of the stomachs of ruminants—in the caecum and colon of the horse and to a lesser extent in the large intestine of all animals. This bacterial digestion breaks down the cellulose and pentosans of feeds into usable organic acids (chiefly acetic and butyric acid) and possibly into simple sugars (such as glucose). This process also results in (1) the production of gases (principally carbon dioxide and methane) which are eliminated as wastes, and (2) the production of heat, which is of no value unless it is needed in maintaining body temperature.

Bacterial digestion is of great practical importance in the nutrition of mature beef cattle, sheep, and horses and is the fundamental reason why they can be maintained chiefly on roughages. It has been estimated that 80 and 95 per cent of the total feed supply of beef cattle and sheep, respectively, consists of forages.

Fiber of Young Grasses and Early Cut Hay More Digestible

It must also be remembered that the fiber of growing pasture grass, fresh or dried, is more digestible than the fiber of hay. Likewise, the fiber of early cut hay is more digestible than that of hay cut in the late-bloom or seed stages. The difference is due to both chemical and physical structure, especially to the presence of certain encrusting substances (notably lignin) which are deposited in the cell wall with age.

Optimum Fiber Content of Ration Variable

Young stock of all classes—fattening steers and lambs, high-producing dairy cows, swine, poultry, and work (or running) horses—must have rations in which a large part of the carbohydrate content of the ration is low in fiber and is in the form of nitrogen-free extract. A pig will digest only about 2 per cent of the fiber, whereas the ruminant will digest 50 per cent.

On the other hand, a considerable amount of fiber or bulk in the ration is believed desirable for mature breeding animals of all classes of livestock, especially when too high condition is not desired. Likewise, with young animals being developed for breeding purposes, the increased fiber will tend to develop more growth and not so much fat.

To promote normal physiological activity of the gastro-intestinal tract, one must feed a certain amount of coarse roughage to all classes of farm animals, except possibly to swine. Finely ground roughages will not suffice. As proof of the latter assertion, it is noteworthy that both bulk and roughness appear to be involved in bloat prevention.

FATS:

Lipids (fat and fat-like substances), like carbohydrates, contain the three elements: carbon, hydrogen, and oxygen. Fats are soluble in such organic solvents as ether, chloroform, and benzene. For this reason, grease spots on clothing are usually removed with one of these solvents. As livestock feeds, fats function much like carbohydrates in that they serve as a source of heat and energy and for the formation of fat. Because of the larger proportion of carbon and hydrogen, however, fats liberate more heat than carbohydrates when digested, furnishing approximately 2.25 times as much heat or energy per pound on oxidation as do the carbohydrates. A less quantity of fat is required, therefore, to serve the same function.

FATS VARY IN MELTING POINT AND DEGREE OF UNSATURATION

The physical and chemical properties of fats are quite variable. From a chemical standpoint, a molecule of fat consists of a combination of three molecules of certain fatty acids with one molecule of glycerol. Fats differ in their melting points and other properties depending on the particular fatty acids which they contain. Thus, because of the high content of unsaturated acids (such as oleic and linoleic) and acids of low molecular weight, corn fat is a liquid at ordinary temperatures; whereas, because of the high content of stearic and palmitic acids, beef fat is solid at ordinary temperatures.

Some fatty acids are "unsaturated," which means that they have the ability to take up oxygen or certain other chemical elements. Chemically, these unsaturated acids contain one or more pairs of double-bond carbon atoms. These characteristics are important. The value of linseed oil and varnish is due to their high content of unsaturated fatty acids, by virtue of which oxygen is absorbed when they are exposed to air, resulting in a tough, resistant coating. Likewise, because of their high content of unsaturated fats, soybeans or peanuts, when fed liberally, will produce soft pork.

An unsaturated fat readily unites with iodine, two atoms of this element being added for each double bond. Thus, in experimental work, the iodine number (the number of grams of iodine absorbed by a hundred grams of fat) is an excellent criterion of the degree of unsaturation. Other measures are also used, but the iodine test has been most common in studying the soft-pork problem.

Rancidity of Fats

Because of their unsaturation, fats often become rancid through oxidation or hydrolysis, resulting in disagreeable flavors and odors which lessen their desirability as feeds. The development of rancidity may be retarded through proper storage or by adding antioxidants. The hydrogenation of fats (adding hydrogen to the double bonds) also lessens rancidity. The latter process has long been effectively used in improving the keeping qualities of vegetable shortenings.



Fig. 34. Feed fats affect body fats. The soft lard sample (left) came from hogs fed on a high soybean ration. Both samples of lard had been exposed to room temperature, 70° F. for two hours prior to photographing. (Courtesy, Prof. Sleeter Bull, University of Illinois.)

Feed Fats Affect Body Fats

The nature of the body fat in animals is markedly influenced by the character of the fat in feeds. This phenomenon is of considerable practical importance, as the degree of hardness of the fat is a major factor in determining carcass quality and value. This is particularly true of hogs in which, because of the nature of the feeds consumed in certain areas, the soft-pork problem exists. Likewise, the kind of fat consumed by cows has a similar influence on the nature of the milk fat.

SOME FATS IN RATION DESIRABLE

Common belief to the contrary, animals can tolerate a rather high fat content in the ration. As evidence of this, it is to be noted that sucklings normally handle a relatively large amount of fat, for milk contains 25 to 40 per cent of this nutrient on a dry-matter basis. Aiso, except for the soft-pork problem, no

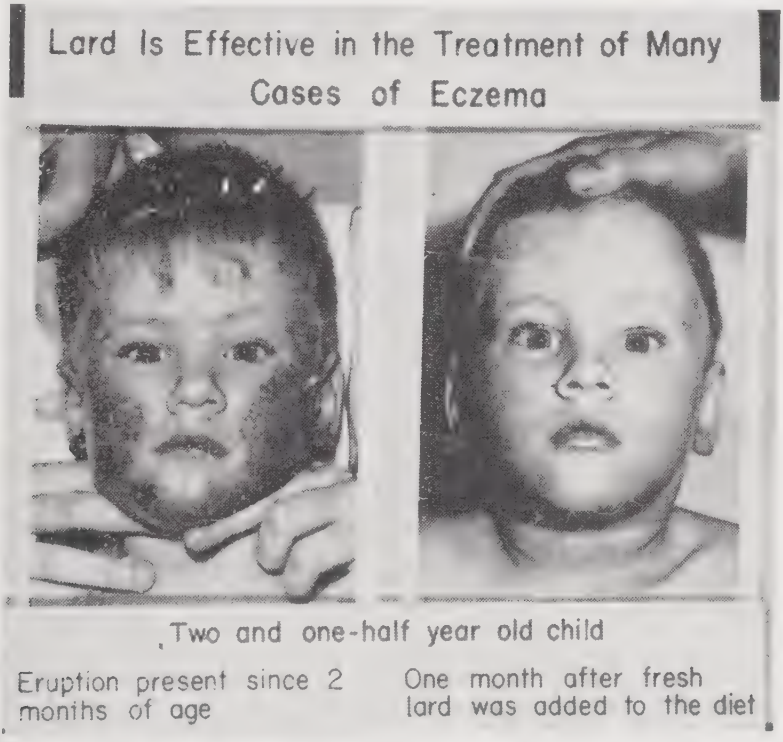


Fig. 35. Some species (human, rats, and dogs) require certain of the fatty acids. Thus, as shown in the illustration, often lard—which contains a relatively large amount of the essential unsaturated fatty acids—is effective in the treatment of eczema. (Studies by Dr. A. E. Hansen, University of Texas, Medical Branch, Galveston; supported by National Live Stock and Meat Board.)

apparent difficulty is encountered in feeding hogs on a rather high fat diet, such as results when large quantities of peanuts or soybeans are fed.

A small amount of fats in the ration is desirable, as these fats are the carriers of the fat-soluble vitamins. There is evidence that some species (humans, rats, and dogs) require certain of the fatty acids. Although the fatty-acid requirements of farm animals have not been settled, it is thought that ordinary farm rations contain ample quantities of these nutrients.

ANIMAL VS. VEGETABLE FATS

The comparative food value of animal and vegetable fats has long been a stormy issue, particularly in regard to the relative merits of butter and oleomargarine or lard and vegetable shortenings. In general, except for the vitamins which they carry, there is no conclusive experimental work to indicate that, as a source of fatty acids, animal fats are superior to vegetable fats. There is reason to believe that margarine, when fortified with vitamins A and D, is—from a nutritional standpoint—just as effective as butter in promoting growth, good health, reproduction, and lactation. There is, however, evidence that some species (humans, rats and dogs) require certain of the fatty acids, but it is quite likely that these differences are unimportant when a normal mixed diet is used. Of course, many people still prefer the spreading qualities and generally greater attractiveness of butter, and many desire to patronize it as a more genuinely and naturally home-produced product than margarine.

Mineral Needs

It has long been known that minerals play an important role in animal nutrition. Aside from furnishing structural material for the growth of bone, teeth, and tissue, the minerals regulate many of the vital life processes.

Although acute mineral-deficiency diseases and actual death losses are relatively rare, inadequate supplies of any one of the thirteen essential mineral elements may result in lack of thrift, poor gains, inefficient feed utilization, lowered reproduction, and decreased production of work, milk, or wool. Thus, like a thief in the night, sub-acute mineral deficiencies in farm animals each year steal away millions of dollars in profits from the farmers and ranchers of America and, for the most part, go unnoticed. Only when the mineral deficiency reaches such proportions that it results in excess emaciation, reproductive failure, or death is it likely to be detected.

The results obtained in recent experiments at Purdue University[1] with reference to salt feeding give striking testimony to the important role played by this simple mineral. One pound of salt, purchased at a cost of less than one cent, resulted in a saving of 287 pounds of feed worth $6.37. The pigs that did not receive salt in the ration required 174 pounds more feed per hun-

[1] "Hogs Need Salt. How Should It Be Fed?" Purdue University Agri. Expt. Sta. Mimeo. Circ. No. 18, 1945.

dred pounds of gain, and the rate of gain was only one-half as great. Deficiencies of other minerals may have just as marked effects.

FUNCTION OF, AND ESSENTIAL MINERALS:

Animal bodies contain but small amounts of minerals, the common range being from 2 to 5 per cent, but these constituents are very important. Mineral matter makes up a large part of the skeleton and teeth of the animal, and minerals are essential constituents of the soft tissues, the blood, the fluids of the body, and certain of the secretions.

Approximately 70 per cent of the mineral content of the animal body consists of calcium and phosphorus. About 99 per cent of the calcium and over 80 per cent of the phosphorus are found in the bones and teeth. Since the greatest development of the skeleton takes place in the young, growing animal, it is evident that adequate minerals must be provided at an early age if the bone is to be sound.

The thirteen mineral elements which, up to the present time, have been shown to be essential are: calcium, phosphorus, sodium, chlorine, iodine, iron, copper, manganese, magnesium, sulfur, zinc, potassium, and cobalt. This does not mean that all thirteen of these minerals must always be included in the mineral supplement. As a matter of fact, through careful selection of feeds, most of these elements can be supplied in natural rations. Sometimes, however, special mineral supplements are needed and should be added, but only the specific minerals that are deficient —and in the quantities necessary—should be supplied. Excesses and mineral imbalances are to be avoided.

The evidence available today would indicate that the following seven elements may be of practical concern in animal feeding in most sections of the United States: calcium, phosphorus, sodium, chlorine, iodine, and iron (copper). Cobalt deficiencies exist in scattered areas. The other six essential minerals appear to be secured in ample quantities through the natural feeds produced in the various sections of the United States and for this reason will not receive individual consideration in the discussion that follows.

COMPLEX MINERAL MIXTURES

Most animal husbandmen favor the use of simple mineral mixtures. Either providing an excessive amount of minerals or a complex mineral mixture when it is not necessary is expensive and wasteful, and any imbalances may actually be injurious to

animals. In general, the wise policy consists in knowing the mineral content of the available feeds and providing, in proper amounts, only those essential minerals which are deficient. Once the deficiencies are determined, proper amounts can best be governed by the animals themselves, simply by allowing them free access to a mineral box in which each of the deficient minerals is placed in a separate compartment.



Fig. 36. Calcium made the difference! The pig on the left received an adequate calcium ration, whereas the two pigs on the right received a low calcium ration. Note the difference in the size of the animals, though they are of the same age. (Courtesy, The State College of Washington.)

CALCIUM AND PHOSPHORUS

Farm animals are more likely to suffer from a lack of phosphorus and of calcium than from any of the other minerals except common salt. These two minerals comprise about half the ash of the skeleton and from one-third to one-half of the minerals of milk. Calcium is very important for growth, reproduction, milk production, and other body functions. In addition to its use in bone formation, phosphorus aids in the formation of proteins and in changing sugars and starches into milk, energy, and body fat. A deficiency of phosphorus lowers feed utilization

Liberal allowances of calcium and phophorus are especially important for young, growing animals, for those that are pregnant, and for those that are producing milk.

The following general characteristics of feeds in regard to calcium and phosphorus are worth noting:

1. The cereal grains and their by-products and protein supplements of plant origin are low in calcium.
2. The protein supplements of animal origin and legume forage and rape are rich in calcium.
3. The cereal grains and their by-products are fairly high or even rich in phosphorus.
4. Most all protein-rich supplements are high in phosphorus.
5. Beet by-products and dried forages (legumes, grass hays, and fodders—unless grown on phosphorus-rich soils) are likely to be low in phosphorus.
6. The calcium and phosphorus content of plants can be increased through fertilizing the soil upon which they are grown.



Fig. 37. Bone chewing by cattle is a common sign of phosporus deficiency. (From Texas Station Bulletin 344, through the courtesy of the National Fertilizer Association.)

The Calcium-Phosphorus Ratio and Vitamin D

In considering the calcium and phosphorus requirements of animals, it is important to realize that the proper utilization of these minerals by the body is dependent upon three factors: (1) an adequate supply of calcium and phosphorus, (2) a suitable ratio between them (somewhere between one to two parts of calcium to one to two parts of phosphorus), and (3) sufficient vitamin D to make possible the assimilation and utilization of

the calcium and phosphorus. Many "cure-alls" and commercial mineral mixtures either fail to take such factors into consideration or their cost is too great.

If plenty of vitamin D is present (as provided either by sunlight or through the ration), the ratio of calcium to phosphorus becomes less important. Also, less vitamin D is needed when there is a desirable calcium-phosphorus ratio.

Calcium and Phosphorus Deficiencies

Young and high-producing animals are most likely to be affected by deficiencies of calcium and/or phosphorus because of their greater needs for these minerals, but older animals do suffer from deficiencies. A decided deficiency of calcium or phosphorus or a lack of vitamin D will cause rickets in growing animals and osteomalacia in mature animals. A full discussion of each of these nutritional diseases follows in the section devoted to nutritional diseases and ailments.

Recommended Calcium and Phosphorus Supplements

Table 7 gives several sources of calcium and phosphorus and the approximate percentages of the two elements in various mineral supplements.

Feeding steamed bone meal, which furnishes both calcium and phosphorus, is the most common farm or ranch supplement where these two minerals are needed. Likewise, this supplement is most commonly used to correct deficiencies of phosphorus

TABLE 7

MINERAL SUPPLEMENTS[1]

Mineral supplement	Calcium per cent	Phosphorus per cent
Bone meal, steamed	30.0	13.9
Defluorinated superphosphate	28.3	12.3
Defluorinated phosphate rock	21.0	9.0
Defluorinated phosphate rock	29.0	13.0
Dicalcium phosphate	26.5	20.5
Monocalcium phosphate	16.0	24.0
Spent bone black	22.0	13.1
Monosodium phosphate		22.4
Disodium phosphate		8.6
Limestone	38.3	
Oyster-shell flour	36.9	

[1]Obtained from report IV on "Recommended Nutrient Allowances for Beef Cattle," published by the Committee on Animal Nutrition of The National Research Council. Because of the limited number of products on the market, figures are given for two types of defluorinated rock that are being produced for livestock feeding.

alone. Where calcium alone is needed, ground limestone or oyster-shell flour are commonly used.

Precautions Relative to Calcium and Phosphorus Supplements

Earlier experiments cast considerable doubt on the availability of phosphorus when the phosphorus was largely in the form of phytin. Although wheat bran is very high in phosphorus, containing 1.32 per cent, there was some question as to its availability due to the high-phytin content of this product. More recent studies, however, indicate that cattle and perhaps swine can utilize phytin phosphorus and that such feeds as wheat bran do provide a satisfactory source of phosphorus under normal farm conditions for these species. It must be emphasized, however, that phosphorus availability depends to a large extent on dietary supplies of calcium and especially on adequate vitamin D. Recent work indicates that high-calcium levels enhance the formation of the insoluble phytin salt from phytic acid, whereas high vitamin-D levels aid materially in the utilization of phosphorus in the form of phytin. On the other hand, in the case of man, the evidence seems clear that phytin phosphorus is a less satisfactory source of phosphorus.

Likewise, for humans, the availability of the calcium of certain leafy materials is impaired by the presence of oxalic acid—the acid precipitating the calcium and preventing its absorption. Thus, it was a great consolation to many people to discover that, due to the high oxalic-acid content of spinach, this food possesses very questionable value in human nutrition from the standpoint of calcium. On the other hand, the deleterious effects of oxalic acid are reduced in the ruminant because of its apparent ability to metabolize oxalic acid in the body.

During World War II, many "defluorinated phosphates," made from rock phosphate, made their appearance upon the market. Usually, unprocessed rock phosphate contains from 3.5 to 4.0 per cent fluorine, whereas feeding steamed bone meal contains only 0.03 to 0.04 per cent. Fortunately, processes have been developed for removing this excess fluorine so that the products can be fed with safety, but the livestock feeder must make very certain that such steps have been taken. In its official publication for 1946, the Association of American Feed Control Officials set forth the following tentative regulations regarding the fluorine content of mineral substances:

> "The fluorine content of any mineral or mineral mixtures that are to be used directly for the feeding of

domestic animals shall not exceed 0.30 per cent for cattle; 0.35 per cent for sheep; 0.45 per cent for swine; and 0.60 per cent for poultry."

Excess fluorine results in abnormal development of the bones; softening, mottling, and irregular wear of the teeth; roughened hair coat; delayed maturity; and less efficient utilization of feed. In general, when defluorinated phosphate contains less than 0.2 per cent fluorine, it can be safely substituted for feeding steamed bone meal in livestock feeding.

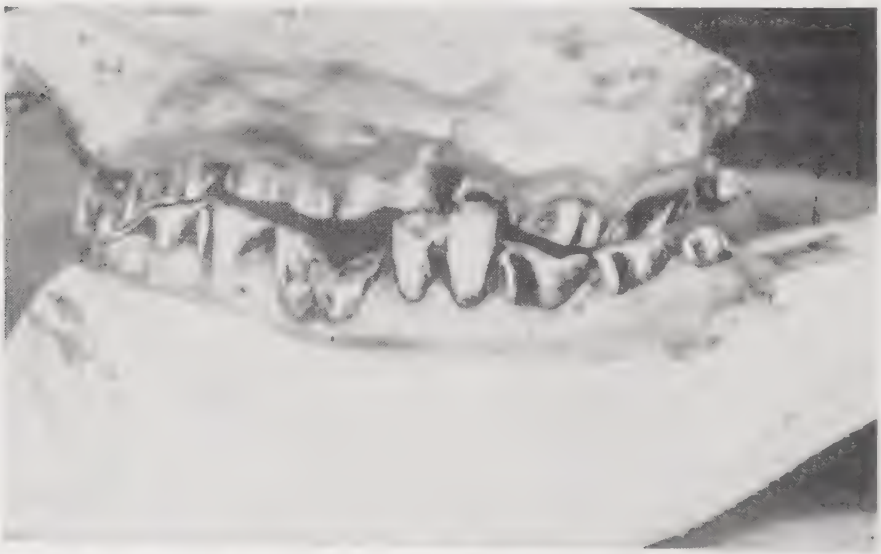


Fig. 38. Excess fluorine results in softening, mottling, and irregular wear of the teeth in both animals and man. (From Michigan Bulletin 129, through the courtesy of The National Fertilizer Association.)

Sodium Chloride or Common Salt

Salt, which serves as both a condiment and a nutrient, is needed by all classes of animals, but more especially by Herbivora (grass-eating animals). It may be provided in the form of loose salt, lumps or rock salt, or salt blocks. In general, the form selected is determined by price and availability. It is to be pointed out, however, that very hard block and rock salt are difficult for stock to eat, often resulting in sore tongues and inadequate consumption.

Both sodium and chlorine are essential for animal life. They are necessary in maintaining the osmotic pressure of body cells (thereby assisting in the transfer of nutrients to the cells and the removal of waste materials), and chlorine is required for the formation of the hydrochloric acid in the gastric juice. The blood

contains 0.25 per cent chlorine and 0.16 per cent sodium; thus the chlorine content is higher than that of any other mineral in the blood, and the sodium content is exceeded only by potassium, which averages about 0.20 per cent. The salt requirement is greatly increased under conditions which cause heavy sweating, thereby resulting in large losses of this mineral from the body. For this reason, both horses and humans when engaged in hard work and perspiring profusely should receive liberal allowances of salt.

Precautions in Feeding Salt

Salt can be fed free-choice to cattle, sheep, swine, and horses provided that they have not previously been "salt-starved." That is, if the animals have not previously been fed salt for a considerable length of time, they may overeat, resulting in digestive disturbances and even death. Salt-starved animals should first be hand-fed salt, and the daily allowance should be increased gradually until they start leaving a little in the mineral box. When this point is reached, self-feeding may be followed. The Indians and the pioneers of this country handed down many legendary stories about the huge numbers of buffalo and deer that killed themselves simply by gorging at a newly found "salt-lick" after having been salt starved for long periods of time.

IRON AND COPPER

Although the body contains only approximately 0.004 per cent of iron[1], this element is vital to life itself, because the oxygen needed by the tissues for the life processes is transported in the blood by the hemoglobin, an iron-containing compound. Also, minute amounts of iron are present in other cells and tissues. Traces of copper are necessary, along with iron, for hemoglobin formation. A variable body store of both iron and copper is located in the liver and spleen, with some iron being found in the kidneys.

Iron and Copper Deficiencies

If animals are fed diets that are too low in iron, or in iron and copper, nutritional anemia will result. Although the incidence of nutritional anemia is widespread—particularly in young pigs—among cattle and sheep, the disease is much more prevalent in Florida in this country and in certain areas of New Zealand, Tasmania, Southern Scotland, and in Kenya Colony of British

[1]The body of a mature human contains a total of about one-tenth ounce of this mineral.

East Africa. A full discussion of anemia follows in the section devoted to nutritional diseases and ailments.

Recommended Iron and Copper Supplements

There is seldom any lack of iron or copper in the normal rations of farm animals, except perhaps during the suckling period. But even here, nature has planned wisely. Young mammals are born with a store of these minerals in their bodies, which usually suffices until they normally begin to eat feeds which supply these constituents. This is most fortunate, as milk



Fig. 39. Anemia or "thumps" in young pigs can usually be prevented by placing a little clean sod in the pen daily. (Courtesy, Prof. E. F. Ferrin, University of Minnesota.)

is very low in iron. Only when young animals are continued on a milk diet for an abnormally long period of time, particularly under confined conditions and with little or no supplemental feeds, will nutritional anemia develop.

When pigs suffer from anemia, a shovelful of clean dirt thrown into the pen daily will provide adequate iron and copper. Another method of providing these minerals consists of swabbing daily the udders of the sows with a saturated solution of copperas (ferrous sulfate). In such iron- and copper-deficient areas as found in Florida, anemia in cattle, sheep, goats, and hogs (an ailment commonly called "salt sick") may be prevented or suc-

cessfully treated by providing the animals with a mineral mixture consisting of a hundred pounds of common salt, twenty-one pounds of red oxide or iron, and one pound of finely ground copper sulfate.

Rich natural sources of iron include the leafy portions of plants, meats, legume seeds, cereal grains, and cane molasses. As most of the iron in cereal grains is located in the outer coatings and germ, milling increases the supply to animals but decreases it so far as humans are concerned.

Precautions in Feeding Iron and Copper

In obtaining sources of iron, it is well to remember that simple inorganic iron salts, such as ferric chloride, are readily utilized, whereas the iron in the complex organic compounds in the hemoglobin of the blood is much less readily available, if at all. Also, though certain small amounts of iron are very essential, too much of this element in the diet may be actually deleterious —interfering with phosphorus absorption by forming an insoluble phosphate—and rickets may thus result on a diet otherwise adequate.

In any mineral mixtures containing copper, thorough mixing must be obtained in order to prevent copper poisoning. Only limited quantities of copper can be put into the mineral mixture for the same reason (five parts per million appears adequate for sheep).

IODINE

It is estimated that the mature animal body contains less than 0.00004 per cent of iodine, but, if this minute amount is not maintained by the diet, disaster results. More than half of the total iodine content of the body is located in the thyroid gland of the neck. Iodine, which is secreted by the thyroid gland in the form of thyroxin (an iodine-containing compound), controls the rate of metabolism of the body.

Iodine Deficiencies

If the soil—and the water and food crops coming therefrom —are low in iodine, the body is likely to show deficiency symptoms in the form of simple goiter, unless an adequate source of iodine is provided artificially. However, iodine-deficiency symptoms are not always evidenced by the appearance of goiter, though this is the most common characteristic of such deficiency in humans, calves, lambs, and kids. In pigs, the outstanding symptom of the deficiency is hairlessness, whereas in foals the

only symptom may be extreme weakness at birth, resulting in an inability to stand and suck. Cows and ewes give birth to goiterous (big-neck) calves and lambs, respectively. There is also some evidence to indicate that "navel ill" in foals may be lessened by feeding iodine to brood mares. In general, it may be said that goiter is an advanced symptom of iodine deficiency but that the chief loss is from interference with reproductive processes and the birth of weak, deformed offspring that fail to survive.

In the United States, the northwestern states, the Pacific Coast, and the Great Lakes region are classed as goiter areas. A full discussion of goiter follows in the section devoted to nutritional disease and ailments.

Recommended Iodine Supplements

The simplest method of supplying iodine in deficient areas is through use of stabilized iodized salt, instead of ordinary salt. Such salt should contain 0.02 per cent of potassium iodide, which is equivalent to one ounce of potassium iodide in each three hundred pounds of salt. Stabilization of the iodine has been perfected through adding a reducing agent called sodium thiosulfate (frequently referred to as hyposulfite of soda or "hypo"), which protects the iodine from destruction (oxidation). Most of the salt companies now manufacture stabilized iodized salt.

With the exception of fish meal, made from saltwater fish, dried kelp (a sea plant), and cod liver oil, none of the common feedstuffs are rich sources of iodine.

Precautions in Feeding Iodized Salt

Although iodized salt is an effective preventive measure, no satisfactory treatment has been developed for animals which have developed pronounced deficiency symptoms. In fact, studies with goiter in humans have clearly established that, although iodine is an effective preventative, it may be harmful rather than beneficial as a treatment after the goiter has developed.

If stabilized iodized salt cannot be secured, a home product may be prepared by thoroughly mixing one ounce of potassium iodide (KI) to three hundred pounds of salt. It must be remembered, however, that this unstabilized product may become worthless from the standpoint of providing iodine, if allowed to stand for any considerable length of time before being eaten. Oxidation of the unstabilized product and consequent loss of iodine is accentuated through exposure to air, sunlight, moisture, and especially inorganic catalysts present in the salt, such as salts of copper, iron, and manganese.

Iodized salt should always be kept in a dry place and it should be kept as fresh as possible. It should also be provided in such form and quantities as to insure an adequate intake of iodine.

In no instance should iodine be fed in excess. Such excesses have proved toxic to lambs, and very probably the same hazard applies to other classes of livestock. For this reason, thorough mixing of iodized salt is important, whether it be a commercial or a home-prepared product.

COBALT

Recently cobalt has been demonstrated to be essential in the nutrition of cattle and sheep. Along with copper and iron, it is needed for the formation of hemoglobin. Cobalt-deficient areas have been reported in Australia, western Canada, and the states of Florida, Michigan, Wisconsin, and New Hampshire in this country. Other areas are suspected.

Animals suffering from a cobalt deficiency grow listless, lose appetite and weight, become weak and anemic, and finally die. Frequently a depraved appetite is noted.

Only minute quantities of cobalt are required. Although more experimental work is sorely needed, it is assumed that intakes of 0.1 mg. per hundred pounds of body weight are ample. In no instance should cobalt be added to the ration if it is not needed, and then excesses are to be avoided because of possible toxicity.

METHOD OF FEEDING MINERAL SUPPLEMENTS:

It is preferable to allow animals free access to mineral supplements, with each mineral placed in a separate compartment of a suitable box or self-feeder. The particular needs of the animals will guide them in consuming sufficient of those elements necessary to correct any deficiencies of the ration. If the minerals are incorporated in the grain ration, the animals may either consume too much or not enough, and mineral imbalances are likely to be forced upon the animals. Where the free-choice method is followed, it is necessary to guard against "mineral-starved" animals. Such animals should be gradually accustomed to the minerals in order to prevent gorging and digestive disturbances.

Vitamin Needs

Until early in the twentieth century, if a ration contained proteins, fats, carbohydrates, and minerals—together with a certain amount of fiber—it was considered to be a complete diet.

True enough, the disease known as beri-beri made its appearance in the rice-eating districts of the Orient when milling machinery was introduced from the West, having been known to the Chinese as early as 2600 B. C.; and scurvy was long known to occur among sailors fed on salt meat and biscuits. However, for centuries these diseases were thought to be due to toxic substances in the digestive tract caused by pathogenic organisms rather than food deficiencies, and more time elapsed before the discovery of vitamins. Of course, there was no medical profession until 1835, the earlier treatments having been based on superstition rather than science.

Largely through the trial-and-error method, it was discovered that specific foods were helpful in the treatment of certain of these maladies. In 1747, Lind, a British naval surgeon, showed that the juice of citrus fruits was a cure for scurvy. Lunin, as early as 1881, had come to the conclusion that certain foods, such as milk, contain, beside the principal ingredients, small quantities of unknown substances essential to life. Eijkman, working in Java in 1897, had satisfied himself that the disease beri-beri was due to the continued consumption of a diet of polished rice. We are told also that, at a very early date, the Chinese used a concoction rich in vitamin A as a remedy for night blindness. Also, codliver oil was used in treating or preventing rickets long before anything was known about the cause of the disease.

The significance of these observations relative to diet, however, was not fully appreciated until scientists found it desirable in many types of investigations to use the biological approach, with purified diets to supplement chemical analyses in measuring the value of foods. These rations were made up of relatively pure nutrients—proteins, carbohydrates, fats, and minerals—from which the unidentified substances were largely excluded. With these purified rations, all investigators shared a common experience: the animals limited to such diets not only failed to thrive, but they even failed to survive if the investigations were continued for any length of time. At first, many investigators explained such failures on the basis of unpalatability and monotony of the rations. Finally, it was realized that these purified rations were lacking in certain substances, minute in amount and the identity of which were unknown to science. These substances were essential for the maintenance of health and life itself and the efficient utilization of the main ingredients of the food. With these findings, a new era of science was issued in. The modern approach to nutrition was born.

Funk, a Polish scientist working in London, first referred to these nutrients as "vitamines" in 1912. Presumably, the name "vitamines" alluded to the fact that they were essential to life, and they were assumed to be chemically of the nature of amines (the chemical assumption was later proved incorrect, with the result that the "e" was dropped—thus the word vitamin).

The actual existence of vitamins, therefore, has been known only since 1912, and only within the last few years has it been possible to see or touch any of them in a pure form. Previously, they were merely mysterious invisible "little things" known only by their effects. In fact, most of the present fundamental knowledge relative to the vitamin content of both human foods and animal feeds was obtained through measuring their potency in promoting growth or in curing certain disease conditions in animals—a most difficult and tedious method. For the most part, small laboratory animals were used, especially the rat, guinea pig, pigeon, and chick.

The rapid increase in our knowledge of vitamins has resulted in a striking shift in emphasis on nutritional problems. Thirty-five years ago, nutritionists were chiefly concerned with the quality and quantity of proteins and minerals and with problems in energy metabolism. Today, the chief emphasis, from a research standpoint, is on vitamins.

The lack of vitamins in a ration may, under certain conditions and in a more limited way, be more serious than a short supply of feed and may result in serious economic losses. On the other hand, such vitamin deficiencies are less widespread throughout the world than hunger itself, for actual starvation has always stalked across much of the world, being referred to as famine only when the numbers killed approach the millions.

Under practical conditions, the rations of farm animals usually contain adequate quantities of each of the several vitamins. However, deficiencies may occur during periods (1) of extended drought or in other conditions of restriction in diet, (2) when production is being forced, (3) when large quantities of highly refined feeds are being fed, or (4) when low-quality forages are utilized.

To date, there is not sufficient knowledge of nutrition to enable the scientist to intelligently recommend the purchase and use of vitamins from the corner drugstore in balancing out livestock rations. Also, these synthetic sources are still quite expensive, and, besides, most nutritionists are agreed that the best

source of vitamins, for both humans and animals, is that obtained in natural sources from a well-balanced diet.

The absence of one or more vitamins in the ration may lead to a failure in growth or reproduction, or to characteristic disorders known as deficiency diseases. In severe cases, death itself may follow. Although the occasional deficiency symptoms are the most striking result of vitamin deficiencies, it must be emphasized that in practice mild deficiencies probably cause higher total economic losses than do severe deficiencies. It is relatively uncommon for a ration, or diet, to contain so little of a vitamin that obvious symptoms of a deficiency occur. When one such case does appear, it is reasonable to suppose that there must be several cases that are too mild to produce characteristic symptoms but which are sufficiently severe to lower the state of health and the efficiency of production. It is also to be emphasized that different species of animals vary in their needs for the vitamins. Also, not all animals suffer from the same deficiency diseases. Thus man, the monkey, and the guinea pig react severely to the absence of the antiscorbutic vitamin in the ration, whereas fowls and ruminants are unaffected.

It has long been known that the vitamin content of feeds varies considerably according to soil, climatic conditions, and curing and storing. More recently, scientists have found that it is possible to increase the content of certain vitamins in milk, eggs, and meat by liberal feeding of those vitamins.

THE KNOWN VITAMINS:

Table 8 contains a list of the known vitamins, the existence of which is undisputed, each one having been proved an essential dietary constituent for one or more species. It is also quite likely that several others will be added to the list. A number of the known vitamins have been isolated chemically and even synthesized. Also, many of them can be distinguished by chemical and physical properties as well as by biological and bacteriological assay. Each of the vitamins is as much a distinct chemical compound as is cane sugar, for example. Although they are present in foods in exceedingly minute amounts, the vitamins are extraordinarily potent.

In Table 8, only a brief presentation is made relative to (1) the function of the vitamins, (2) some deficiency symptoms, (3) animals most affected, and (4) good animal sources of each of the vitamins. In reviewing this, it must be remembered that single, uncomplicated vitamin deficiencies are the exception

rather than the rule. Multiple deficiencies are altogether too common, making diagnosis difficult even to the trained observer. In addition to the summary in Table 8, some general comments of interest are contained in the section which follows, and a discussion of each of the vitamin deficiency diseases is contained in the section devoted to nutritional diseases and ailments.

For further information on this voluminous subject, the reader is referred to texts on biological chemistry and to books, articles, and current journal articles dealing exclusively with this subject.

VITAMIN A

Vitamin A is required by all farm animals and man. It is strictly a product of animal metabolism, no vitamin A being found in plants. The counterpart in plants is known as carotene, which is the precursor of vitamin A. Because the animal body can transform carotene into vitamin A, this compound is often spoken of as *Provitamin A*.

Carotene is the yellow-colored fat soluble substance that gives the characteristic color to carrots and to butterfat. (Vitamin A is nearly a colorless substance.) Carotene derives its name from the carrot from which it was first isolated over one hundred years ago. Although its empirical formula was established in 1906, it was not until 1919 that Steenbock discovered its vitamin-A activity. Though the yellow color is masked by the green chlorophyll, the green parts of plants are rich in carotene and thus have a high vitamin-A value. Also, the degree of greenness in a roughage is a good index of its carotene content. Early cut, leafy green hays are very high in carotene.

Aside from yellow corn, practically all of the cereal grains used in livestock feeding have little carotene or vitamin-A value. Even yellow corn has only about one-tenth as much carotene as well-cured hay. Dried peas of the green and yellow varieties, carrots, yellow sweet potatoes, yellow pumpkins and squash are also valuable sources of carotene.

On most farms and ranches, adequate vitamin A can be supplied for all classes of animals by allowing access to green pastures in the grazing season and through providing green, leafy hay (ground legumes for swine), or good quality silage for winter feeding. The circumstances most conducive to vitamin-A deficiencies are (1) extended periods of drought, resulting in the pastures becoming dry and bleached; (2) a long winter feeding

TABLE 8

ANIMAL VITAMIN CHART

Name of	Function	Some deficiency symptoms	Animals most affected	Good sources for animals	Comments
Vitamin A	Promotes growth and stimulates appetite, helps to keep the mucous membranes of respiratory and other tracts in a healthy [illegible] infection. Necessary in the regeneration of visual purple, helps to maintain a normal and healthy nervous system, and assists in reproduction and lactation.	Stunted growth or loss in weight and loss of appetite, xerophthalmia (an eye disease), night blindness, nervous incoordination as shown by a staggering gait, and sterility in males and females or young which are born weak or dead.	Affects all farm animals, including poultry.	Green, leafy hays Silages Lush, green pastures Yellow corn Green and yellow peas Fish oils Carrots Whole milk	Vitamin A is found only in animals; plants contain the precursor, carotene (for vitamin A). Animals are able to store considerable vitamin A, but because of their greater requirements and less storage, young animals suffer from a deficiency much sooner than those that are mature. Both carotene and vitamin A are readily destroyed by oxidation, thus resulting in considerable losses in processing and storing (as in making hay or storing of hay).
Vitamin D	Aids in the assimilation and utilization of calcium and phosphorus and is necessary in normal bone development of animals, including the bone of the fetus.	Rickets in young and osteomalacia in mature animals and congenital malformations in the newborn, which may be due to a lack of vitamin D.	Affects all farm animals, including poultry.	Sun-cured and artificially dehydrated hays Cod and certain other fish-liver oils Direct sunlight Irradiated yeast Irradiated ergosterol	When animals are exposed sufficiently to direct sunlight, the ultra-violet light in the sunlight penetrates the skin and produces vitamin D from traces of certain cholesterols in the tissues. Tissue storage is very limited.
Vitamin E	[illegible] for normal reproduction in rats and poultry, necessary for proper health of all animals and the development of the muscular and vascular systems.	"Stiff-lamb disease" in sheep	Rat, sheep, and perhaps certain other animals.	Wheat-germ oil Cereal grains and other seeds Green pastures Good-quality hay	This factor is widely distributed in all natural feeds, even in corn cobs. Thus the addition of wheat-germ oil to ordinary farm rations is of doubtful value.
Vitamin K	Aids in the clotting of blood and the prevention of hemorrhage.	Blood failing to clot; sweet clover disease.	Deficiency symptoms have been reported in various birds and in mice, rats, rabbits, and man. Thought to be needed by all species but probably synthesized in the rumen or intestines.	Green pastures Well cured hays Fish meal In general, this factor is widely distributed in normal farm rations. Also, all classes of farm animals synthesize it.	Vitamin K has definite value in human therapy where clotting of the blood needs to be induced. It has also been helpful in the treatment of "hemorrhagic sweet clover disease" in animals.
Vitamin C or Ascorbic Acid	Formation of the intercellular substances of the teeth, bones, and soft tissues, increases resistance to infection, pro[illegible]	Scurvy: swollen, bleeding, and ulcerated gums, loosening of teeth, and weak bones.	Dietary need is limited to man, the guinea pig and the monkey. Probably required by other species but synthesized in the body.	Citrus fruits Green pastures Well-cured hays	Ordinary farm rations and body synthesis appear to provide adequate vitamin C.
[illegible] Factor	Aids in prevention of fragility and permeability of capillaries.		Unknown	Citrus fruits (Content of farm feeds is unknown.)	There is still some question as to whether this reported factor is entitled to be classed as a vitamin.

TABLE 8 (Cont'd)

Name of vitamin	Function	Some deficiency symptoms	Animals most affected	Good sources for animals	Comments
THE KNOWN B VITAMINS					
B_1 or Thiamine	Promotes appetite and growth, required for normal carbohydrate metabolism, aids reproduction.	Beri-beri in man and polyneuritis in birds. In most species, there appears to be loss of appetite and retarded growth, enlarged heart and slowing of the heart beat, lower body temperature, and lowered reproduction or failures in both sexes with prolonged deficiencies.	All animals must have a dietary source, unless there is rumen synthesis as in ruminants.	Green pastures Well-cured, green, leafy hays Cereal grains Peas Brewer's yeast	Although farm animals require thiamine, it is not of practical importance since all natural rations containing even a small percentage of cereal grains will most likely be adequate in B_1.
Riboflavin	Promotes growth and functions in the body as a constituent of several enzyme systems and as such is important in carbohydrate and amino-acid metabolism.	Retarted growth in most species, with a wide variety of other symptoms somewhat variable with the species. Periodic ophthalmia (moon blindness) in horses; reproductive failure in the sow, and slow growth, anemia, diarrhea, unthrifty appearance, eye opacities, and an abnormal gait in the young pig.	Thought to be required by all animals but deficiency symptoms not observed in ruminants, perhaps due to rumen syntheses. Deficiency symptoms noted in poultry, swine, and horses.	Green pastures Well-cured, green, leafy hays Milk and milk products Meat scraps and fish meal	Grains are poor source of riboflavin. Many common rations are borderline or deficient in riboflavin, especially swine rations.
Niacin or Nicotinic Acid	Functions as a hydrogen carrier in the oxidation of food, essential to growth and health.	Pellagra in man and "black tongue" in dogs. Swine exhibit loss of appetite, vomiting, slow growth, diarrhea, and a dry and harsh hair and skin.	It is a dietary essential of pigs, chickens, monkeys, and man. Apparently synthesized in the digestive tract of ruminants (sheep and cattle) and the horse.	Cereals and their by-products, except corn, are good sources Animal by-products Green alfalfa is a fair source	This factor is widely distributed among common feeds, thus making deficiencies in natural rations rather unlikely. May be of benefit in swine rations high in corn.
Vitamin B_6 or Pyridoxine	Basic in amino acid and fat metabolism.	Rats develop a symmetrical dermatitis (acrodynia) and fail to grow; pigs exhibit poor appetite, slow growth, unsteady gait, convulsions, anemia, and fatty livers.	B_6 is a dietary essential for the rat, pig, chick, and dog. It is synthesized in the rumen of cattle and sheep and perhaps in the caecum of the horse; thus no deficiency symptoms in these species have been reported.	Cereal grains and their by-products Rice bran and polished rice Green pastures Well-cured alfalfa hay Yeast	Normally, the ration is not lacking in vitamin B_6.

TABLE 8 (Cont'd)

Name of	Function	Some deficiency symptoms	Animals most affected	Good sources for animals	Comments
THE KNOWN B VITAMINS CONTINUED					
Acid	Not clearly established, but probably important in carbohydrate metabolism.	There seems to be a specie difference in symptoms. Swine exhibit an incoordinated, goose stepping gait, enteritis, slow growth, abnormal appetite, and some loss of hair. In rats and dogs, there is graying and loss of hair.	Rats, dogs, pigs, chickens, and turkeys. Synthesized in rumen of cow and sheep; perhaps the horse also synthesizes it.	Widely distributed in the foods of both animal and plant origin. Cereal grains and their by-products. Green pastures Well-cured hay	A deficiency in the commonly fed rations of farm animals seems improbable, with the possible exception of swine rations.
Biotin	Known to be necessary for the maintenance of health in some species. Biotin is involved in carbohydrate metabolism.	Pigs exhibit spasticity of the hind legs, cracks in the feet, and a dermatitis. There is also lowered efficiency of feed utilization.	It is required in the diets of rats, poultry, dogs, rabbits, monkeys, pigs, and probably other species.	Animal feeds have been little studied relative to biotin content. Yeast, milk, egg yolk, liver, and kidney are especially rich.	Ordinary farm rations probably contain ample biotin, or farm animals synthesize all they need.
Folic Acid	Of importance in hemoglobin formation, necessary for normal reproduction in	Lowered reproduction in swine.	Not too much is known about species, but deficiency symptoms have been produced in chicks, monkeys, rats, swine, and humans.	Some animal proteins, well-cured, green leafy alfalfa; green pastures.	Folic acid is widely distributed in both plants and animals. It was given this name because of the abundance of the factor in plant leaves.
		It stimulates biotin synthesis in the pig.	Little is known as to animals affected.		
Benzoic Acid		Loss of hair color in the rat.	Little known but of no benefit to the pig when added to purified ration.		
	Functions in amino-acid and fat metab- in swine.	Fatty livers in most species, perosis in poultry. Gestating-lactating sows on choline deficient rations farrow an abnormal number of weak pigs: pigs exhibit muscular incoordination, heavy mortality, and	Swine, rats, and poultry. Choline deficiency has not been observed in man.		With a high protein diet, enough choline is synthesized from certain precursors and amino acids. Deficiency symptoms are more readily obtained as the protein content is lowered.
	Stimulates appetite, increases the rate of growth and the efficiency of feed utilization, and necessary for normal reproduc-	in swine, rats, and poultry.	Swine, rats, and poultry.	Protein supplements of animal origin, and APF supplements	Also known as "animal protein factor," "cow manure factor", and/or "anti-pernicious anemia factor." A specific treatment for human anemias.

period on bleached hays or straws, especially over-ripe cereal hays and straws; (3) using feeds which have lost their vitamin-A potency through extended storage (for example, it has been found that alfalfa-leaf meal may lose nine-tenths of its vitamin-A value in a year's storage), or (4) the dry-lot feeding of swine predominantly on cereals, especially if yellow corn is not included in the ration. There is reason to believe that mild deficiencies of vitamin A, especially in the winter and early spring, are fairly common.



Fig. 40. A ram lamb showing some vitamin A deficiency symptoms. Note the difficulty in standing. (Courtesy, The State College of Washington.)

VITAMIN D

Like vitamin A, vitamin D is required by all farm animals and man. Most of the commonly used feeds contain little or no vitamin D, yet there is no widespread need for special supplements containing this factor. Fortunately, the skin of animals and many feeds contain the provitamins in certain forms of cholesterol and ergosterol, respectively, which, through the action of ultra-violet light (light of such short wave length that it is invisible) from the sun, is converted into vitamin D. These certain forms of cholesterol and ergosterol themselves have no anti-rachitic effect.

Of all the known vitamins, vitamin D has the most limited distribution in common feeds. Very little of this factor is contained in the cereal grains and their by-products, in roots and tubers, in feeds of animal origin, or in growing pasture grasses. The only important natural sources of vitamin D are hay and other roughages. The chief vitamin-D-rich concentrates include cod-liver and other fish oils, irradiated cholesterol and ergosterol, and yeast.

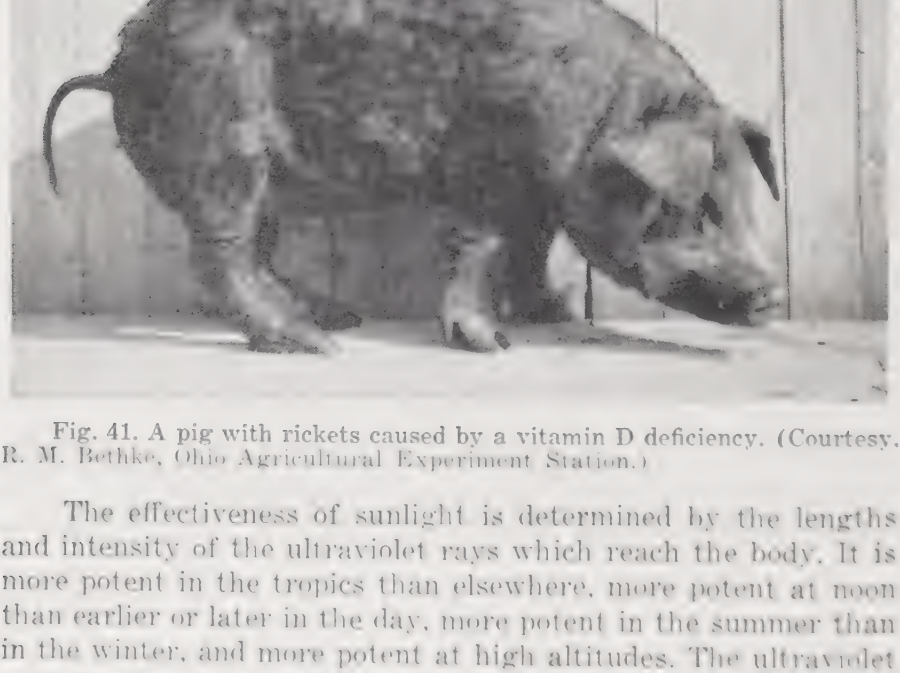


Fig. 41. A pig with rickets caused by a vitamin D deficiency. (Courtesy, R. M. Bethke, Ohio Agricultural Experiment Station.)

The effectiveness of sunlight is determined by the lengths and intensity of the ultraviolet rays which reach the body. It is more potent in the tropics than elsewhere, more potent at noon than earlier or later in the day, more potent in the summer than in the winter, and more potent at high altitudes. The ultraviolet rays are largely screened out by clothing, window glass, clouds, smoke, or dust. Recent work indicates that artificially dehydrated forages may be satisfactory as sources of vitamin D.

VITAMIN E

Although it has been established that vitamin E is necessary for normal reproduction in the rat and chick and other small animals, there is no conclusive evidence to indicate that it is necessary for reproduction in the larger farm animals. Moreover, there appears to be an abundance of this factor in all natural feeds; even corn oils are a good source. Thus, the addition of vitamin E rich concentrates, such as wheat-germ oil, to ordinary

farm rations is of doubtful value. Exception may be necessary with sheep, in which species it may be desirable to add a vitamin-E-rich concentrate when certain rations are used. Save for the expense involved, however, no harm will result from adding reasonable quantities of wheat-germ oil to any ration and for any species.

VITAMIN K

Present information would indicate that there is no need of giving consideration to the vitamin-K content of the ration of farm animals, except in the case of poultry. Green pastures and green, leafy hays are rich sources of this vitamin, and various other products contain substantial amounts. Also there is rumen and intestinal synthesis in farm animals.

VITAMIN C

Apparently this vitamin is not of importance in feeding farm animals. Although this factor is probably required for various species—other than man, monkeys, and guinea pigs—it is synthesized in ample quantities in the body. Moreover, all green forages (pastures, hays, or silages) are high in vitamin C.

THE KNOWN B VITAMINS

The original vitamin, known as vitamin B, has now been found to be composed of a large number of vitamins or vitamin-like factors. This condition has made the terminology most confusing. Some of these factors have been isolated and recognized; whereas others are not so well known. Still others appear to be on the way to discovery.

In 1948, vitamin B_{12} was isolated by Merck and Company as the anti-anemia factor in liver; subsequent experimental studies have revealed that this is the elusive factor long known to be of importance in swine nutrition and to exist in animal proteins (the "animal protein factor") and cow manure (the "cow manure factor"). Table 8 contains a brief summary of our present knowledge of vitamin B_{12}.

The known B vitamins either appear in adequate quantities in normal farm rations or are sufficiently synthesized by micro-organisms in the digestive tract (the rumen of sheep and cattle or the caecum and colon of the horse) to properly satisfy the requirements of sheep, cattle, and horses. Therefore, the requirements of these classes of animals for the B vitamins will not be pursued further in this discussion.

Unlike these classes of livestock, however, the pig merely has one stomach (and no large caecum like the horse). As a result, the pig does not synthesize enough of certain B vitamins. Consequently, these factors must be provided through the ration if deficiencies are to be averted.

It is also to be emphasized that sub-acute deficiencies can exist although the actual deficiency does not appear. In fact, borderline deficiencies are both the most costly and the most difficult to cope with, going unnoticed and unrectified. Such borderline deficiencies result in poor and expensive gains.

Also, under farm conditions one will usually not find a vitamin deficiency which involves only a single vitamin. In other

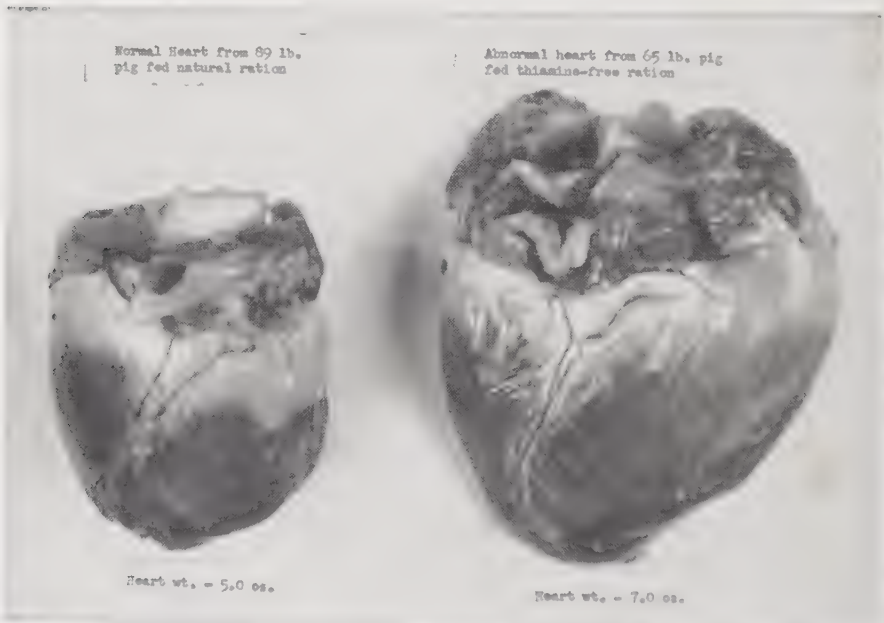


Fig. 42. Enlargement of the heart of a pig caused by a B vitamin deficiency. (Courtesy, The State College of Washington.)

words, deficiencies usually represent a combination of factors, and usually the deficiency symptoms will not be clear-cut.

Inspection of Table 8 would indicate that, even with swine, the farmer can meet the B-vitamin requirements of the pig by following sound and practical feeding practices. In general, this involves the maximum use of pasture throughout the grazing season and the feeding of generous quantities of a well-cured



Fig. 43. All pigs from sows that received a riboflavin deficient ration during gestation were either born dead or died within 48 hours. (State College of Washington experiment.)



Fig. 44. Showing retarded growth in pigs as a result of a niacin deficiency. The ages of the two pigs were approximately the same, and the rations were identical except that the one vitamin, niacin, was left out of the feed of the stunted pig on the right. (Courtesy, Journal of Nutrition; and Dr. M. M. Wintrobe, University of Utah.)



Fig. 45. Pig showing vitamin B_6 or pyridoxine deficiency symptoms. Note difficulty in walking. (Courtesy, Dr. E. H. Hughes, University of California.)



Fig. 46. Pig showing pantothenic acid deficiency symptoms. Note high, goose stepping gait. (Courtesy, Dr. E. H. Hughes, University of California.)

green, leafy alfalfa meal during those seasons or times when pastures are not available; with animal proteins added to the ration of young pigs and gestating-lactating sows. Since the B-vitamin problem applies largely to swine, however, this discussion will be pursued further in the section devoted completely to this class of animals.



Fig. 47. Pigs from a sow that received a choline deficient ration during the gestation period. Note the weak, spraddle-legged condition of the pigs. (State College of Washington experiment.)

A BALANCED RATION PLUS SUNLIGHT WILL USUALLY SUPPLY AMPLE VITAMINS:

Good feeding practices with roughages (exposed to sunlight) and concentrates produced on fertile soils will supply most of the vitamins (and most of the minerals) that are required by farm animals, with the possible exception of young pigs and gestating-lactating sows. This implies the use of as nearly year-around pastures as possible and the winter feeding of well-cured, leafy, green hays. The winter ration of hogs may include ground hay in proper quantity, whereas the winter forage of cattle, sheep, and horses may consist of hay or a combination of hay and silage.

Antibiotic and Vitamin B_{12} Needs[1]

The newer knowledge of antibiotics—products of molds, bacteria, and green plants—dates from the discovery of penicillin in 1928.[2] However, penicillin did not come into prominence until ten years later, and it was not until 1944 that streptomycin, the second most widely known of the antibiotics, was discovered by Wakesman, a soil scientist at the New Jersey station, and his colleagues.

Penicillin, streptomycin, and other antibiotics were rushed into use against a long list of human diseases, ranging from common flu to radiation sickness. They were hailed as the "wonder drugs" of our time, but no one thought of them, even remotely, as something new to be added to livestock feeds. Finally, in 1949, quite by accident, while conducting nutrition studies with poultry, Jukes of Lederle Laboratory and McGinnis of the State College of Washington, obtained startling growth responses from feeding a residue from aureomycin production. Later experiments revealed that the supplement used by McGinnis and Jukes — the residue from aureomycin production — supplied growth-promoting (1) vitamin B_{12} and (2) aureomycin. Such was the birth of feeding antibiotics to livestock and the ushering in of a new era in animal nutrition.

For years, proteins from animal and fish sources (liver, meat and milk products, and fish meal) have been recognized as superior to plant proteins for non-ruminants. Also, stockmen have observed that growing pigs are more thrifty and gain faster when they follow cattle in feed lots than when kept away from cattle. The nutritional factors responsible for these observations were not known, with the result that the terms "animal protein factor" and "cow manure factor," respectively, were coined to explain the situation.

In 1948, it was found that a chief factor in the superiority of animal and fish proteins was the presence of at least one vita-

[1]To date, the so-called APF Supplements (or antibiotics) have been the most abundant sources of vitamin B_{12}, and until recently, only a limited quantity of either crystalline (pure) antibiotics or vitamin B_{12} have been available for experimental study. Because of their origin and close association, the two products are herein discussed together. It is to be noted, however, that the antibiotics will not replace vitamin B_{12} in animal nutrition, nor will either of these factors substitute for the necessary vitamins and other essential nutrients.

[2]Actually, the presence of antibiotics was known much earlier than the discovery of penicillin, but no commercial use was made of them.

min, now known as vitamin B_{12}. Also, in 1948, it was found that special fermentations could be used as sources of this growth factor. About this same time, it was established that the growth-promoting effect of cow manure was due to vitamin B_{12}, synthesized by microorganisms inhabiting the paunch of cattle.

CLASSIFICATION AND DEFINITION OF ANTIBIOTIC AND VITAMIN B_{12} PRODUCTS:

Until October, 1950, the designations of antibiotic and vitamin B_{12} substances were as confused as their nutritional role. At that time, the American Feed Control Officials adopted the following terminology:

1. **Vitamin B_{12} Supplement**—is a feeding material used for its vitamin B_{12} activity. It shall contain a minimum of 1.5 milligrams of vitamin B_{12} per pound of supplement.

2. **Antibiotic Feed Supplement**—is a feeding material used for its antibiotic activity. It may consist of a single antibiotic or a combination of antibiotics having growth-promoting properties. It shall contain a minimum of 1 gram of antibiotic(s) per pound of supplement.

3. **Vitamin B_{12} And Antibiotic Feed Supplement**—is a feeding material which contains both vitamin B_{12} and antibiotic materials, and which meets the above minimum concentrations of each of these products.

By common use, vitamin B_{12} is known as (1) the anti-pernicious anemia factor, (2) the animal protein factor, or (3) the cow-manure factor.

Commercially produced antibiotics are thought of as substance produced by mold-like organisms grown in nutrient solutions in large steel tanks. Hundreds of antibiotics are known—including commercially produced penicillin, streptomycin, auroeomycin, chloromycetin, terramycin, bacitracin, etc.—and each is effective against one or more kinds of bacteria. The vast majority of antibiotics are too toxic for medical use.

There are on the market a considerable number of Vitamin B_{12} and Antibiotic Feed Supplements (formerly called APF or "Animal Protein Factor" supplements). Each of these numerous products contains three nutritional factors in variable amounts, namely (1) vitamin B_{12}, (2) antibiotics and their residues in crude form, and (3) other fermentation products.

NUTRITIONAL ROLE OF ANTIBIOTIC AND VITAMIN B_{12} PRODUCTS:

At the present time our knowledge of the nutritional role of the antibiotics and vitamin B_{12}, and their possible relationships to each other, is merely opened up. More research work is needed. In the meantime many wild claims and counter claims are being made relative to these new products.

It appears that neither mature ruminants nor mature horses need to have vitamin B_{12} or antibiotics added to natural rations. However, these products are of practical importance in swine and poultry nutrition. Although the final story will not be known until many more investigations are conducted, experimental results to date indicate the following swine nutritional role of the Vitamin B_{12} And Antibiotic Feed Supplements:[1]

1. They provide a source of vitamin B_{12}, heretofore supplied only by protein supplements of animal origin. It is reported that some of these supplements contain 350 times as much vitamin B_{12} as is found in meat and bone scrap.

2. They are effective in stretching the supply of protein supplements of animal origin. Since animal proteins have always been in shorter supply and higher in price than other feeds, this is important.

3. They make it possible to formulate satisfactory rations at a lower cost, because (1) cheaper and more abundant protein supplements of plant origin can be used, and (2) smaller amounts of digestible protein are needed in the ration.

4. They stimulate the appetite and cause more rapid gains, enabling the producer to reach an earlier market at a younger age. On the average growing-fattening pigs make 10 to 20 per cent faster gains (sometimes more).

5. They make for greater feed efficiency, resulting in less feed per hundred pounds pork (on the average, 4 to 5% less feed).

6. They (some kinds of these materials, at least) control certain types of scours, and lessen runtiness.

7. They increase the bloom and cause a smoother hair coat.

8. They give less response when fed to healthy animals in a healthy environment than when fed to unhealthy animals in an unhealthy environment.

[1] All the feeding results herein reported pertain to swine. Similar results have been obtained with poultry. Also it has been shown that young calves are greatly benefited when these products are added to the ration.

9. They vary in their effects on swine, according to (1) the levels fed, (2) the particular kind or combination of antibiotics, (3) the health and environment of the animal, (4) the type of ration, and (5) the age of the animal (being most effective in promoting the growth of young animals).

10. They may be effective, so it is conjectured, (1) because of eliminating harmful, toxic-producing micro-organisms found in the intestinal tract, or (2) because of stimulating the growth of some beneficial organisms which synthesize some needed factor or factors.

Some glowing reports to the contrary, there is no evidence to indicate that the use of the "wonder drugs" can or will alleviate the need for vigilant sanitation, improved nutrition, and superior management. Instead, with the unfolding and applying of scientific information relative to them, the producer will be able to achieve still greater efficiency of production.

ADDING ANTIBIOTIC AND VITAMIN B_{12} PRODUCTS TO THE RATION:

Based on the above information, the progressive swine producer will wish to be on the alert relative to incorporating these products in practical swine rations. Reputable commercial feed companies are already doing this. Both the farmer, who mixes his own feeds, and the commercial feed company can buy these products and **thoroughly mix them according to the directions obtained from manufacturers.**

The following general guides may be used in determining which supplement or supplements to add to the swine ration:

1. When the ration possesses liberal quantities of vitamin B_{12}—containing animal protein supplements (meat and milk products, and/or fish meal), it is recommended that Antibiotic Feed Supplement only be added.

2. When the protein content of the ration is derived chiefly or entirely from plant proteins (peanut, linseed, cottonseed, and/or soybean meals), it is recommended that there be added either (1) a combination of (a) Vitamin B_{12} Supplement and (b) Antibiotic Feed Supplement, or (2) Vitamin B_{12} and Antibiotic Feed Supplement—whichever is the cheaper.

At the present time, crystalline (pure) antibiotics are too expensive for swine feeds, and, besides, they cannot be purchased from the corner drug store without a prescription from a

medical doctor (M.D.) or a veterinarian (D.V.M.). However, crude supplements, which are entirely satisfactory for livestock feeding purposes, can be purchased from reputable manufacturers or feed stores.

Water Needs

Water is one of the most vital of all nutrients. In fact, animals can survive for a longer period without food than they can without water. Yet comparatively little discussion will be given to this nutrient simply because, under ordinary conditions, it can be readily provided in abundance and at little cost.

Water is one of the largest single constituents of the animal body, varying in amount from 40 per cent in fat hogs to 80 per cent in newborn pigs, 50 per cent in a 1,000 pound steer to 70 per cent in a newborn calf, and 50 per cent in a fat lamb to 80 per cent in a newborn lamb. In general, the percentage of water in the bodies of animals varies with their species, condition, and age. The younger the animal, the more water it contains. Also, the fatter the animal, the lower the water content. Thus, as an animal matures, it requires proportionately less water on a weight basis, because it consumes less feed per unit of weight and the water content of the body is being replaced by fat. This accounts for the fact that gains in older animals are more costly than those in younger animals.

Water performs the following important functions in animals:

1. It is necessary to the life and shape of every cell and is a constituent of every body fluid.
2. Water acts as a carrier for various substances, serving as a medium in which nourishment is carried to the cells and waste products are removed therefrom.
3. It assists with temperature regulation in the body, cooling the animal by evaporation from the skin as perspiration.
4. It is necessary for many important chemical reactions of digestion and metabolism.
5. As a constituent of the synovial fluid, it lubricates the joints; as cerebrospinal fluid, it acts as a water cushion for the nervous system; as perilymph in the ear, it transports sound; and in the eye, it is concerned with sight and provides a lubricant for the eye.

Surplus water is excreted from the body, principally in the urine, and to a slight extent in the perspiration, feces, and water vapor from the lungs.

The specific water requirements of each class of animals will receive further consideration in the sections devoted to the respective species. In general, however, under practical conditions, the needs for water can best be taken care of by allowing the animals free access to plenty of clean, fresh water at all times.

GOOD LIVESTOCK REQUIRE GOOD SOILS

The good stockman can be identified by the appearance of his animal. A good animal is proof of good breeding and superior nutrition, and proper nutrition is obtained by feeding hays, grains, and pastures which are grown on fertile soils.

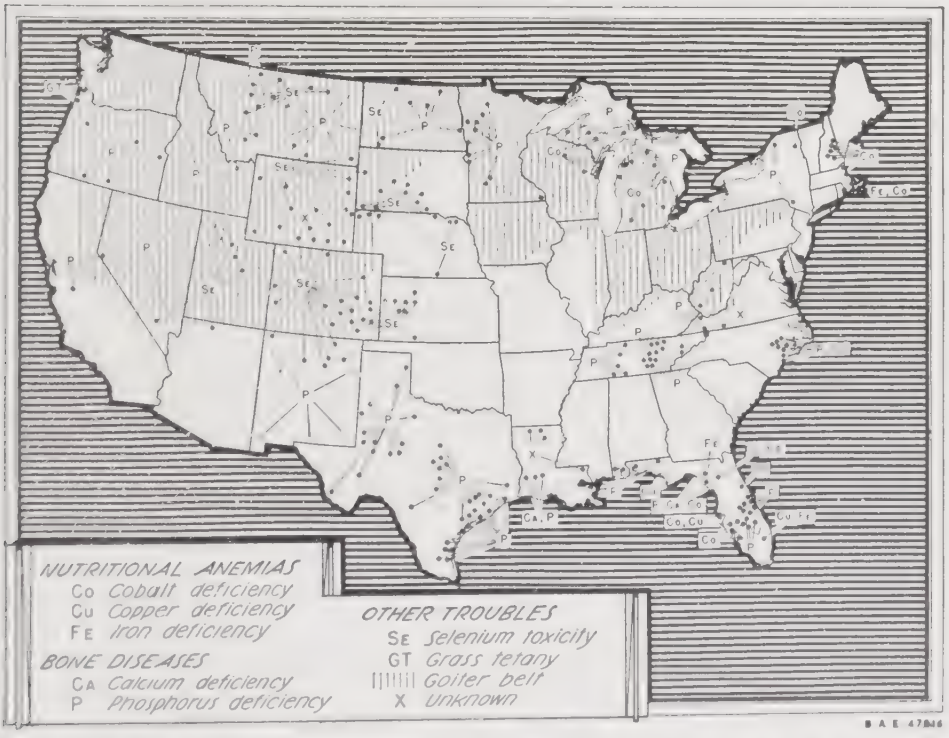


Fig. 48. Mineral deficiency areas of the United States and the excess selenium area of the Northern and Central Great Plains. (From U.S.D.A. Yearbook, 1948.)

In the wild state, animals did not possess the many bone unsoundnesses and nutritional deficiencies common to domesticated livestock. The animals roved over the prairies or through the forests, gleaning the feeds provided by nature—vegetation

produced on highly mineralized, unleached soils—whereas, on a modern farm the range is restricted, leached, and sometimes entirely devoid of vegetation. Domestic animals have little or no choice in the selection of their diet, being able to consume only what the caretaker provides or what can be grazed within the confines of fenced holdings. The condition is further aggravated by forcing early development and high production, such as is obtained in racing two- or three-year-olds, in producing high yields of milk and butterfat, the fattening of baby beeves, the farrowing of gilts at one year of age and the marketing of pigs at four to six months of age, and the simultaneous production of a heavy fleece and a fat market lamb.



Fig. 49. Good livestock do require good soils. The fine pedigree of this jack could not overcome the mineral deficiencies of feeds produced on poor soils. (Picture obtained from Dr. W. A. Albrecht, University of Missouri, through the courtesy of the National Fertilizer Association.)

Present research, together with practical observation, points to the fact that the mere evaluation of yields in terms of tons of forage or bushels of grain produced per acre is not enough. Neither do standard feed analyses tell the story. Rather, there appears to be a direct and most important relationship of the fertility of the soil to the composition of the plant in terms of calcium, phosphorus, proteins, vitamins, and other nutrients. Moreover, the animal cannot be expected to be well nourished

when forced to subsist on plants which themselves are suffering from such nutritive deficiencies. Since the needs for these nutritive constituents for the development of strong bone and healthy bodies is fully understood, it may truly be said that "good animals require good soil."

Unsuccessful attempts are constantly being made to overcome these nutritive deficiencies of plants by dosing the animal with patent mineral and vitamin mixtures. Unfortunately, at times, such "cure-alls" may even accentuate the difficulty, because of harmful imbalances in calcium or phosphorus and possibly other nutrients. Therefore, the wise policy consists of first



Fig. 56. Shin bones from two calves of similar breeding and age. Small bones (left pair) obtained from calf pastured on "belly deep" grasses grown on highly weathered but untreated soil. Heavy bones (right pair) obtained from calf pastured on grasses grown on moderately weathered but fertilized soil, including "trace" elements. (Courtesy, Dr. W. A. Albrecht, University of Missouri.)

improving the fertility of the soil, which in turn means well-nourished and highly nutritious forages and grains for the animal. Soil fertility can best be improved through adding crop residues, manure, and certain commercial fertilizers as required. Restoring depleted soils not only increases the mineral, protein, and perhaps vitamin content of plants; but the tonnage yield of the crop will be higher.

The rapidity of soil leaching is always greatest in areas of high rainfalls and high temperatures, which means the eastern and southern parts of the United States. It can also be stated that the failure of a soil to grow an adapted legume is an indication of lack of calcium. In such areas, the nutritive deficiencies of animals are more prevalent.

Under certain conditions and in certain areas where mineral deficiencies become very severe, "deficiency areas" become known. Thus, southwestern United States is known as a phosphorus-deficient area, northwestern United States as an iodine-deficient area, and southeastern United States as a cobalt-deficient area.

FEEDING AS AN ART

The feed requirements of animals do not necessarily remain the same from day to day or from period to period. The age and size of the animal, the kind and degree of activity, climatic conditions, the kind, quality, and amount of feed, the system of management, and the health, condition, and temperament of the animal are all continually exerting a powerful influence in determining the nutritive needs. How well the feeder understands, anticipates, interprets, and meets these requirements usually determines the success or failure of the ration and the results obtained. Although certain principles are usually followed by all good feeders, no book knowledge or set of instructions can substitute for experience and born livestock intuition. Skill and good judgment are essential to the feed lot. Indeed, there is much truth in the old adage that "the eye of the master fattens his animals."

The discussion that follows will primarily be directed at the fattening operations of cattle, sheep, and hogs. The maintenance of the breeding herds and flocks will receive special attention in the respective sections devoted to each class of farm animals.

Starting Animals On Feed

In cattle and lamb feeding operations, it is important that the animals be accustomed to feed gradually. In general, upon arriving at the feed lot, the animals may be given as much non-legume roughages as they will consume. On the other hand, it is necessary that they be gradually accustomed to high-quality legumes which may be too laxative. The latter can be accomplished by slowly replacing the non-legume roughage with greater quantities of legumes. Of course, as the grain ration is increased the consumption of roughages will be decreased.

Starting cattle and lambs on grain requires care and good judgment. With both classes of stock, it is usually advisable to first accustom them to a bulky type of ration, a starting ration with considerable oats or beet pulp being excellent for this purpose. A common "rule of thumb" in starting cattle on feed is to give them two pounds per head the first day; increase the ration by from one-half to one pound daily until they reach approximately the halfway mark of what is anticipated will be a full feed; and then increase the ration by one pound every third day until full feeding is obtained. Lambs are usually started on grain by feeding about one-fourth pound per head daily, gradually increasing the allowance so that they are getting a feed of about two pounds per head daily when on full feed four to five weeks later.

In general, little difficulty is ever encountered in starting hogs on feed. Although the same precautions that apply to cattle and sheep should be observed, swine are less sensitive to feed changes than other classes of farm animals.

The keenness of the appetites and the consistency of the droppings of the animals are an excellent index of their capacity to take more feed. In all instances, scouring, the bane of the feeder, should be avoided.

Amount To Feed

Many farm animals throughout the United States are underfed all or some part of the year. Temporary underfeeding is most likely to occur in the winter months or during periods of extended droughts. Fortunately, during such times of restricted feed intake animals have nutritive reserves upon which they can draw. Although they may survive for a considerable period of time under these conditions, there is an inevitable loss in body weight and condition.

Overfeeding is also undesirable, being wasteful of feeds and creating a health hazard. Animals that suffer from mild digestive disturbances are commonly referred to as "off feed." When overfeeding exists, there is usually considerable left-over feed and wastage, and there is a high incidence of bloat (colic in horses), founder, scours, and even death.

When on full feed, fattening cattle will consume 1¾ to 2½ pounds of concentrates and from ¾ to 2 pounds of hay per 100 pounds of live weight daily. Lambs on full feed will consume about 2 pounds of grain per head daily and about the same amount of roughage. The proportion of grain to roughage for

cattle and sheep should be varied according to their comparative price and the age and quality of the animals. Fattening hogs will consume four to five pounds of feed, mostly concentrates, per hundred pounds of live weight. The pig, therefore, is capable of consuming more feed in proportion to body weight than can either the cow or sheep. This is a major factor in the greater efficiency with which pigs convert feeds into meats. Regardless of the ration or class of stock, however, fattening animals should receive a maximum ration over and above the maintenance requirement.

Frequency, Regularity, and Order of Feeding

In general, fattening animals are fed twice daily. With animals that are being fitted for show, where maximum consumption is important, it is not uncommon to find three feedings daily. When self-fed, animals eat at more frequent intervals, though they consume smaller amounts each time. Horses or mules at work should be fed three times per day.

Animals learn to anticipate their feed. Accordingly, they should be fed *with great regularity*, as determined by a time piece. During warm weather, they will eat better if the feeding hours are early and late, in the cool of the day.

Usually, the grain ration is fed first, with the roughage following. In this manner, the animals eat the bulky roughages more leisurely.

Feeds Should Not Be Changed Abruptly

Sudden changes in diet are to be avoided, especially when changing from a less-concentrated ration to a more-concentrated one. When this rule of feeding is ignored, digestive disturbances result, and animals go "off feed." In either adding or omitting one or more ingredients, the change should be made gradually. Likewise, caution should be exercised in turning animals out to pasture or in transferring them to more lush grazing. If it is not convenient to accustom them to the new pasture gradually, they should at least be well filled with hay (or with the former pasture) before being turned out.

Selection of Feeds

In general, the successful feeder balances out the ration through selecting those feeds which are most readily available at the lowest possible cost. In addition, consideration is given to supplying quality proteins, the proper minerals, and the necessary vitamins. Attention is also given to the laxative or constipating

qualities of feeds and the palatability of the ration. Furthermore, the relation of the feeds to the quality of product produced should not be overlooked. In dairy cows it is known that certain feeds have a tendency to produce soft or "salvy" butter, and in fattening hogs, excessive quantities of soybeans or peanuts produce soft pork.

Attention to Details Pays

The successful feeder pays great attention to details. In addition to maintaining the health and comfort of the animals and filling their feed troughs, consideration is also given to their individual likes and temperaments.

It is important to avoid excessive exercise, which results in loss of energy by the animals through unnecessary muscular activity. Rough treatment, excitement, and noise usually result in nervousness and inefficient use of feed. Fattening animals and milking cows should not be required to exercise any more than is deemed necessary for the maintenance of health. Dehorning is usually necessary in order to reduce fighting and possible bruises or injury. Likewise, all males should be castrated; for they will be much quieter, and the quality of the meat will be enhanced.

HAND-FEEDING VERSUS SELF-FEEDING

Self-feeding is the most common method of feeding employed in the fattening of hogs. Though less prevalent, the practice is increasing in cattle- and lamb-fattening operations. It is also the usual method employed in fattening mules for market, but it is almost never used with horses.

Self-feeding may be satisfactorily accomplished in either of two ways; namely through (1) providing a suitable self-feeder or hopper-type of container or (2) keeping a large-type feed bunk (trough for swine) well filled at all times. In order to self-feed cattle or sheep, they must be hand-fed until they are on full feed, after which they may have free access to the self-feeder.

The principal advantages derived from the use of self-feeders are as follows:

1. Less labor and time is required in the feeding operations. By using self-feeders with large bins or hoppers, a large quantity of feed—enough for a week or two—may be mixed and placed before the animals at one time. Hand-feeding is a twice-a-day chore, whereas it is merely necessary to check the filled self-

feeders at intervals to make certain that the feed has not "clogged."

2. Slightly higher feed consumption and larger daily gains are secured. This is especially true when hand-feeding is done by an inexperienced feeder or when more or less irregularity occurs in time of feeding and quantity and character of rations—conditions which sometimes prevail under ordinary farm conditions.

3. Self-fed animals are usually ready for market earlier than hand-fed animals because of their slightly more rapid gains.

4. The animals are less likely to "go off feed." This is because they learn that feed is available at all times, with the result that they are inclined to eat leisurely. On the other hand, greedy steers or lambs are likely to gorge when hand-fed, particularly at those times when weather conditions may cause them to come to the feed trough with very keen appetites.

5. Often self-feeders are especially well adapted to grain feeding on pastures due to the distance of the pastures from the feed storage and mixing facilities.

6. With most feeds, pigs can be relied upon to balance out their own rations when fed cafeteria style; thus considerable time can be saved in the mixing of feeds.

The principal disadvantages of using self-feeders are the following:

1. Unless the chopped roughage is thoroughly mixed with the grain ration, self-feeding is not adaptable where it is desired to utilize the maximum quantity of roughage. This is simply due to the fact that, under self-fed conditions, the animals elect to eat a large proportion of grain. Thus, where roughages are abundant and low in price, hand-feeding may be more practical.

2. The gains of self-fed cattle and sheep may cost slightly more, particularly where grains are relatively higher than roughages. However, the slightly higher feed cost is usually offset by the slightly higher selling price of the finished animals.

3. If hopper-type feeders are used, rather than bunks, there is usually a slightly higher equipment cost in self-feeding.

4. Somewhat more time and expense is usually required in preparing feeds (shelling, grinding, and mixing) for the self-feeder.

5. Practical cattle feeders usually consider that self-feeding is not adapted to an extended feeding period, whereas they feel

that it is quite a satisfactory method to use for a short-feed of 90 to 120 days.

6. Unlike pigs, cattle and sheep cannot be trusted to balance their own rations when different feeds are made available on a free-choice basis.

7. With lambs, self-feeding is likely to lead to overeating and higher death losses.

In general, because of the greater quantities of concentrates consumed in self-feeding, it is advisable that the ration used be slightly more bulky than when hand-feeding is used. The extra bulk may be obtained either by (1) adding a small amount of chopped or ground hay to the grain ration or (2) using in the ration a considerable proportion of such bulky, fibrous feeds as oats, beet pulp, or bran. With favorable feed prices, it may be well to have as much as one-third of the ration of cattle and sheep made up of oats, beet pulp, or bran. With brood sows, a generous supply of ground alfalfa should be mixed in the ration, thus providing a bulky, less-fattening ration and furnishing a desirable source for vitamins, minerals, and proteins.

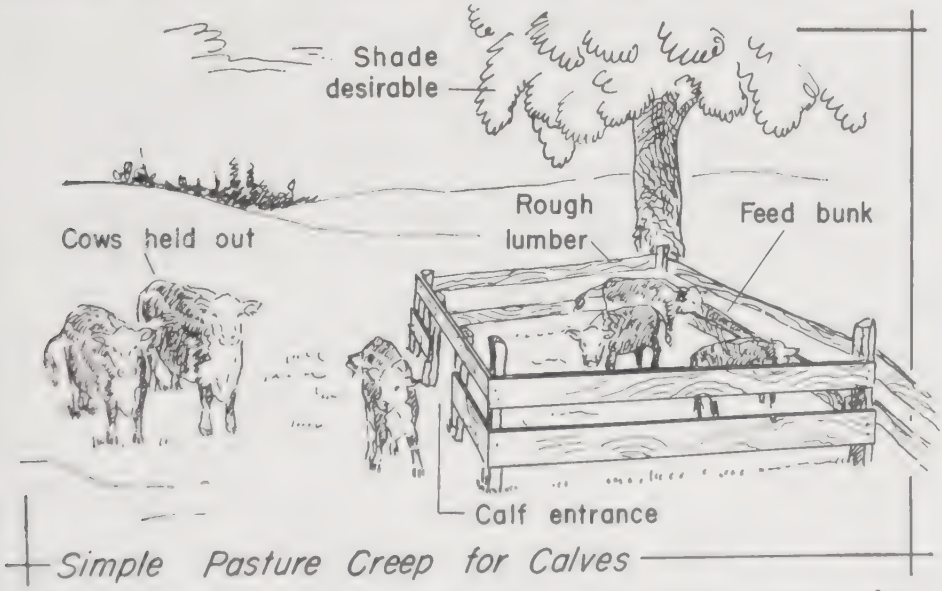


Fig. 51. A creep of this general type can be provided for any class of animals. Note the small creep entrance for the calves and the nearby shade. (Drawing by R. F. Johnson)

CREEP-FEEDING YOUNG ANIMALS

It has always been said that "young gains are cheap gains." This is due to (1) the higher water and lower fat content of the young animal in comparison with older animals, and (2) the higher feed consumption per unit of weight of young animals.

Also, there has been an increasing demand for lighter cuts of meat, with meat animals of all species being marketed at younger ages and lighter weights. These factors have encouraged more and more creep-feeding of calves, pigs, and lambs. The practice of self-feeding of concentrates to young animals in a separate enclosure away from their dams is known as "creep-feeding."

PREPARATION OF FEEDS

Perhaps no problem is so perplexing to the amateur feeder as the proper preparation of feeds. Usually, the confusion is further accentuated by the propaganda of manufacturers and distributors of various feed preparation equipment, not to mention the pet theories of experienced feeders.

1. **Grinding or rolling grains.** In general, small, hard grains —such as rye, wheat, barley, rice, and kafir—should always be ground *coarsely* or rolled when fed to farm animals other than sheep, for they are difficult to masticate and therefore are not efficiently utilized. Unless extremely hard seeds, such as millet, are fed to sheep, they prefer to do their own grinding, and there is no saving from processing. Corn and oats should be ground when there are no hogs following cattle. The value of oats for horses with good teeth is increased only about 5 per cent by grinding or crushing. When corn is used for horses or mules, it is usually fed on the cob or as shelled corn.

Professional caretakers usually prefer rolling to grinding as a means of preparing small grains for horses or for show cattle or show sheep. They claim that the ration is lighter, and less digestive disturbances are encountered. On the other hand, most commercial cattle and sheep feeders grind *coarsely* instead of rolling the grain. Apparently, under such practical conditions, the animals consume more of the less-bulky, ground feed, and the gains are both more rapid and more efficient. Likewise, because of less bulk, hog feeds should be ground rather than rolled.

In all cases, fine, floury particles should be avoided. Finely ground feed is unpalatable, and it is masticated with difficulty—"balling up" in the animal's mouth. Finely ground feeds or mill by-products are frequently fed to pigs in the form of slop.

All concentrates in the dairy ration should either be ground or rolled.

2. **Soaking, cooking (or steaming), or slopping.** Soaking or cooking (or steaming) of feeds is a common practice among professional cattle showmen, heating being especially popular during

the winter months. Such feeds are somewhat more palatable, which is an important factor when animals are being forced to the maximum.

Cooking may slightly increase the digestibility of the starches, but in some instances, at least, heating decreases the digestibility of the proteins appreciably. The latter fact, plus the labor



Fig. 52. Professional showmen insist that palatability and gains are enhanced by cooking feeds. Frank Roach, Beef Cattle Herdsman, State College of Washington, shown pouring cooked grain from an electric feed cooker. (Courtesy, The State College of Washington.)

and fuel charges incident to cooking or soaking, makes such methods of preparation impractical for the commercial cattleman. Potatoes and beans should always be cooked when fed to swine. The practice of feeding concentrate mixtures to swine in the form of a slop or swill has decreased in recent years. However, professional showmen still follow this method, expressing the conviction that slightly greater feed consumption and gains can be obtained thereby.

3. **Shredding and Cutting or Grinding Roughages.** It is usually desirable to cut or shred such fibrous roughages as corn fodder or stover, for they are thus easier for the animals to handle and are cleaned up more thoroughly with less waste. Like-

wise, when alfalfa or some other suitable legume is added to a swine ration, it is best to grind or finely chop the forage, thus permitting thorough mixing with the ration.

Whether it will pay to chop hay will depend upon a number of factors such as (1) the quality and price of the roughage, (2) ease of handling and storing, (3) method of feeding, and (4) quantity fed.

In the large cattle- and sheep-feeding yards of the West, alfalfa hay is usually chopped because of (1) the greater ease in handling, (2) the fact that a larger quantity can be stored under cover at less cost and with less loss, and (3) the reduced waste in feeding the liberal quantities commonly used in an area where alfalfa is generally relatively cheaper than the concentrates.

In the Corn Belt states, chopping is not so prevalent as in the West because grains are relatively more abundant and cheaper and less roughages are fed. It follows, therefore, that the animals waste less forage under such limited feeding.

Except for hogs, the roughage should be coarsely chopped, usually not less than one to two inches in length. Very finely ground hay is apt to be dusty, which is especially undesirable with horses, and the incidence of digestive disturbances and bloat will be higher when fine particles are fed. It should also be remembered that the operation of chopping, within itself, does not improve the quality of the initial product. The feeding of chopped hay merely prevents the animals from selecting out the finer leaves and stems while rejecting the coarse and less palatable particles. For this reason, many practical feeders insist that a roughage of such poor quality as to require chopping—in order to get the animals to consume it—should not be fed in the first place.

If hay is chopped directly into the barn, it must be quite dry in order to avoid heating and possible spontaneous combustion. It is also quite important that unusual precaution be taken to prevent foreign objects from getting into the chopper because (1) animals are less able to avoid such objects when they are mixed in with chopped hay, and (2) when the hay is being chopped directly into the barn, such objects may start a fire as they pass through the chopper.

HOME-MIXED VERSUS COMMERCIAL FEEDS

The value of farm-grown grains—plus the cost of ingredients which need be purchased in order to balance the ration, and

the cost of grinding and mixing—as compared to the cost of commercial ready-mixed feeds laid down on the farm, should determine whether it is best to mix feeds at home or depend on ready-mixed feeds. Although there is nothing about the mixing of feeds which is beyond the capacity of the intelligent farmer or rancher, under many conditions a commercial mixed feed supplied by a reputable dealer may be the most economical and the least irksome. The commercial dealer has the distinct advantages of (1) purchase of feeds in quantity lots, making possible price advantages, (2) economical and controlled mixing, and (3) the hiring of scientifically trained personnel for use in determining the rations. Because of these advantages, commercial feeds are finding a place of increasing importance in American agriculture. Also, it is to the everlasting credit of reputable feed dealers that they have been good teachers, often getting stockmen started in the feeding of balanced rations, a habit which is likely to remain with a stockman whether or not he continues to buy commercial feeds.

NUTRITIONAL DISEASES AND AILMENTS

Forced production (such as very high milk yields and marketing of animals at early ages) and the feeding of forages and grains which are often produced on leached and depleted soils has created many problems in nutrition. This condition has been further aggravated through the increased confinement of stock, many animals being stall-fed all or a large part of the year. Under these unnatural conditions, nutritional diseases and ailments have become increasingly common.

Although the cause, prevention, and treatment of most of these nutritional diseases and ailments are known, they continue to reduce profits in the livestock industry simply because the available knowledge is not put into practice. Moreover, those widespread nutritional deficiencies which are not of sufficient proportions to produce clear-cut deficiency symptoms cause even greater economic losses because they go unnoticed and unrectified.

A number of the nutritional diseases and ailments affecting farm animals will now be discussed.

Rickets

Rickets is a disease of young animals—of calves, foals, pigs, lambs, kids, pups, and chicks—which is characterized by a failure of growing bone to ossify, or harden, properly.

SYMPTOMS:

Those bones which are rapidly increasing in length, such as the long bones of the legs and ribs, are most likely to be visibly affected. There is a noticeable enlargement of the knee and hock joints, and the animal may exhibit signs of great pain when moving about, caused by the eroding away of the cartilages of the joints. The union of the ribs with the breastbone cartilage also bulges irregularly, producing the well-known "beaded-rib" (or "rachitic rosary") condition. The bones become softened, resulting in bowed legs and other distortions. With swine, there is frequently a paralysis of the hind legs.



Fig. 53. Calf with severe rickets. Note the emaciation, humping of back, swelling of joints, knuckling of pasterns, and bowing of legs. Rickets may be caused by a lack of either calcium, phosphorus, or vitamin D, or by an incorrect ratio of the two minerals. (From Michigan State College Bulletin 150, through the courtesy of The National Fertilizer Association.)

CAUSE, PREVENTION, AND TREATMENT:

Rickets may be caused by a lack of either calcium, phosphorus, or vitamin D or by an incorrect ratio of the two minerals. The disease may be prevented by supplying these nutrients, practical sources of which have already been discussed.

If the disease has not advanced too far, treatment may be successful by supplying adequate amounts of vitamin D and adjusting the intake and the ratio of calcium and phosphorus.

Osteomalacia

In mature animals of all species, lack of vitamin D or an inadequate intake or incorrect ratio of calcium and phosphorus

produces mineral-deficiency diseases which are somewhat different from rickets. In such cases, calcium and phosphorus are withdrawn from the bones to meet the need for these minerals by the body. As a result, the bones become porous and weak and are easily broken. Affected animals often become lame or stiff, because of injury to the joints. As would be expected, most of the acute cases occur during pregnancy and lactation when excessive demands are made upon the bones. The condition is more frequent when the diet is inadequate.

For purposes of convenience, all such calcium and phosphorus deficiencies are grouped under the name of osteomalacia. It is recognized, however, that many authorities insist upon further breakdown, to differentiate between cause and effect. Accordingly, the following terms are frequently used in referring to calcium and phosphorus deficiencies in mature animals; osteoporosis, osteofibrosis, aphosphoresis, and acalciosis.

SYMPTOMS:

Mature animals suffering from a phosphorus deficiency have a depraved appetite (gnawing bones, wood, or other objects, or eating dirt), lack of appetite, stiffness of joints, failure to breed regularly, markedly decreased milk production, and an emaciated appearance. The animals also exhibit a characteristic stiffness of joints.

Calcium deficiency, which is much more rare than a phosphorus deficiency, results in fragile bones, reproductive failures, and lowered lactation.

CAUSE, PREVENTION, AND TREATMENT:

In general, widespread and severe calcium and phosphorus deficiencies are caused by soils being deficient in these elements, so that the feeds produced thereon possess the same deficiencies. Southwestern United States is classed as a phosphorus-deficient area; whereas calcium-deficient areas have been reported in parts of Florida, Louisiana, Nebraska, Virginia, and West Virginia.

The best prevention of osteomalacia consists of feeding balanced rations produced on well-fertilized soils. Added and cheap insurance against any such deficiencies consists of allowing the animals free access to a suitable phosphorus and calcium supplement as needed. In general, calcium deficiencies are very rare in cattle, sheep, and horses; indeed, such deficiencies are exceedingly rare among these species provided that a reasonable amount

of legumes are fed. With swine, phosphorus deficiencies are usually rare because of the high content of this ingredient in grains. Heavy grain feeding, however, often results in a calcium deficiency in this species because grains are low in this mineral.

When caused by faulty diet, calcium and/or phosphorus deficiencies in mature animals may be prevented or treated (if the disease has not advanced too far) in any of the following ways:

1. By increasing the calcium and phosphorus content of feeds through fertilizing the soils.
2. By selecting natural feeds that contain sufficient quantities of calcium and phosphorus.
3. By feeding a special mineral supplement or supplements.

Salt (Sodium Chloride) Deficiency

Common salt is one of the most essential mineral compounds in the diet of herbivorous (grass-eating) animals; but, fortunately, it is one of the easiest and cheapest to provide as a supplement.

SYMPTOMS:

Animals suffering from a deficiency of salt exhibit a loss of appetite, retarded growth and loss of weight, a rough coat, and lowered production of milk. If deprived of salt for an extended period of time, they develop a ravenous appetite for it; and if suddenly given free access to salt, they may gorge, with symptoms of poisoning and serious digestive disturbances—or even death may result.

CAUSE, PREVENTION, AND TREATMENT:

As is fully understood, the cause of a salt deficiency—which primarily affects grass-eating animals and the pig—is the fact that most forages and grains contain little of this mineral. On the other hand, flesh and blood contain considerable salt, so that carnivora (flesh-eating animals) usually secure sufficient quantities in the diet.

Prevention of salt deficiencies consists of providing plenty of salt at all times. Although salt may be mixed in the ration, the free-choice method of feeding is preferable. Salt-starved animals should be gradually accustomed to salt. One should slowly increase the hand-fed allowance daily until the animals may be safely allowed free access to this mineral.

Nutritional Anemia

Anemia is a condition in which the blood is either deficient in quality or quantity. (A deficient quality refers to a deficiency in hemoglobin and/or red cells). Though this condition is most prevalent in suckling young, especially young pigs, it affects all classes and ages of farm animals.

SYMPTOMS:

Nutritional anemia is characterized by loss of appetite, progressive emaciation, and death. Clinical diagnosis reveals a serious lack of hemoglobin in the blood. In suckling swine, the disease is commonly called "thumps," which is characterized by labored breathing, a swollen condition (especially around the head and shoulders), and general weakness.



Fig. 54. An 18-day-old pig with nutritional anemia. Most cases of nutritional anemia are caused by an iron deficiency. (Courtesy, U.S.D.A., Bureau of Animal Industry.)

CAUSE, PREVENTION, AND TREATMENT:

Nutritional anemia is most commonly caused by an iron deficiency, but it may also result from a deficiency of copper, cobalt, or of certain vitamins (riboflavin, pyridoxine, pantothenic acid, and folic acid). Nutritional anemia in suckling animals, caused by iron and/or copper deficiencies is worldwide. In this country, both copper and cobalt are deficient in the soils of Florida, and

cobalt deficiencies under natural conditions have been reported in Michigan, Wisconsin, and New Hampshire. Cobalt deficiencies in farm animals have also been reported in Australia, New Zealand, western Canada, and Scotland. Copper deficiencies have been reported in Great Britain, western Australia, South Africa, Sweden, and Peru.

Prevention of nutritional anemia consists of supplying dietary sources of adequate quantities of all of those nutrients necessary for the normal formation of hemoglobin in the blood, namely: iron, copper, cobalt, and folic acid (and certain other vitamins).

Iron and copper deficiencies in suckling animals can usually be prevented by keeping confined conditions to a minimum and by providing supplemental feeds at as early an age as possible. Prevention of anemia or "thumps" in young pigs can usually be effected by placing a little clean sod in the pen daily or by swabbing the udder of the sow daily with a saturated solution of copperas (ferrous sulphate).

Where copper deficiencies of the soil exist, as in Florida, nutritional anemia in farm animals may be prevented by allowing the animals free access to a mineral mixture consisting of a hundred pounds of common salt, twenty-five pounds of red oxide of iron, and one pound of finely ground copper sulfate. Likewise, anemia in cattle and sheep caused by a cobalt deficiency can be prevented by providing a dietary source of cobalt. Thus, it has been reported in New Zealand that cobalt deficiency in sheep has been successfully controlled through providing free access to a cobaltized salt lick which is made by spraying a solution of four ounces of cobalt chloride on one ton of salt.[1]

If the deficiency symptoms are not too far advanced, anemia treatment consists of providing dietary sources of the nutrient or nutrients deficiencies of which are known to cause the condition.

Iodine Deficiency (Goiter)

Simple goiter in animals is an enlargement of the thyroid gland caused by a deficiency of iodine. It affects all species of farm animals and also humans. It is characterized by an enlargement of the thyroid gland, which is nature's way of attempting to make sufficient thyroxine under conditions where a deficiency exists. It is to be emphasized, however, that goiter is not the only characteristic of an iodine deficiency.

[1]Keeping Livestock Healthy, *Yearbook of Agriculture, 1942*, U. S. Dept. of Agri., p. 390.

SYMPTOMS:

In addition to goiter (an enlargement of the thyroid gland) —which is the most characteristic symptom of iodine deficiency in humans, calves, lambs, and kids—even greater economic losses may result in the form of reproductive failures and the birth of weak, deformed offspring that fail to survive. Pigs may be born hairless; foals may be so weak that they do not have the ability to stand and suck; and cows and ewes may give birth to goiterous (big-neck) calves and lambs, respectively.

CAUSE, PREVENTION, AND TREATMENT:

Iodine deficiency is caused by a failure of the body to obtain sufficient iodine from which the thyroid gland can form thyroxin (an iodine-containing compound). This occurs where the soil and



Fig. 55. Hairlessness in pigs caused by a deficiency of iodine. In iodine-deficient areas, farm animals should receive iodized salt throughout the year. (Courtesy, Dept. of Veterinary Pathology and Hygiene, College of Veterinary Medicine, University of Illinois.)

the water and crops produced therefrom are low in iodine, provided that adequate sources of this mineral are not provided artificially (such as in iodized salt). In general, such iodine-deficient areas are known to exist in northwestern United States and in the Great Lakes region.

Iodine deficiencies in farm animals can be economically and effectively prevented by providing access to iodine compounds.

The simplest method consists of feeding *stabilized* iodized salt. Such salt should contain 0.02 per cent of potassium iodine. In iodine-deficient areas, it is especially important that such iodized salt be made available to brood sows during the last three months of pregnancy, to ewes three to four months prior to parturition, and to gestating mares and cows for five months or more prior to parturition. Better yet, in iodine-deficient areas, it is good insurance to feed iodized salt to all farm animals throughout the year.

Once the iodine-deficiency symptoms appear in farm animals, no treatment has been found particularly effective unless it is started at a very early stage.

Vitamin-A Deficiency (Night Blindness and Xerophthalmia)

All farm animals and man react to a deficiency of vitamin A. This factor functions in the body in numerous ways. It stimulates appetite and promotes growth, helps to keep the mucous membranes of the respiratory and other tracts in a healthy condition so that they will resist bacterial infection, helps to maintain a normal and healthy nervous system, assists in reproduc-



Fig. 51. A 2-year-old heifer showing typical advanced eye lesions accompanying a vitamin-A deficiency. (From California Agricultural Experiment Station Bulletin 560.)

tion and lactation, and combines with a protein to produce visual purple—a light-sensitive pigment of the retina of the eye.

SYMPTOMS:

Night blindness is one of the first and more distinctive symptoms of a vitamin-A deficiency. Afflicted animals give evidence of faulty vision, particularly when forced to move about in twilight in a strange corral or other area in which unfamiliar objects are stationed. In advanced stages of vitamin-A deficiency, xerophthalmia (a severe condition of the eyes), and even blindness, may result with some animals. The ram will not develop xerophthalmia on a vitamin-A deficiency.

CAUSE, PREVENTION, AND TREATMENT:

Vitamin-A deficiency symptoms materialize in animals when there have been insufficient intakes of vitamin A or carotene. Prevention and treatment consists of correcting the dietary deficiencies. Good sources of vitamin A for animals include green, leafy hays; silage; lush, green pastures; yellow corn or green and yellow peas; carrots; whole milk; and fish oils.

Periodic Ophthalmia (Moon Blindness) of Horses

Periodic ophthalmia or "moon blindness" is a condition involving the eyes of horses, mules, and asses. This condition has been known to exist for at least two thouand years, but knowledge of the cause is very recent. The disease is widespread, having been reported in England, Germany, France, Italy, South Africa, the Philippine Islands, and Central and North America. In this country, it occurs most frequently in the states east of the Missouri River.

SYMPTOMS:

Horses afflicted with periodic ophthalmia have periods of cloudy vision—in one or both eyes—which may last for a few days or a week or two and then clear up; but it recurs at intervals, eventually culminating in blindness in one or both eyes.

CAUSE, PREVENTION, AND TREATMENT:

Periodic ophthalmia is caused by a deficiency of riboflavin in the ration. Experimental work at the United States Remount Service at the Front Royal, Virginia station has shown that periodic ophthalmia may be prevented by adding riboflavin to the ration of the horse at the rate of 40 mg. per pound of grain. Fortunately, green pastures and well-cured, green leafy hays are excellent natural sources of riboflavin. Thus, horses that receive generous supplies of these roughages are not likly to be afflicted

by this deficiency disease. No cure for periodic ophthalmia is known.

Stiff Lamb Disease (Or White-Muscle Disease)

The so-called "stiff lamb disease" appears to be of different origin, but at least one type is nutritional.

SYMPTOMS:

The animals have a stiff, stilted way of moving, chiefly in the hind legs, although the front legs and shoulders may be involved. The back is usually humped or "roached." Young lambs one to five weeks of age that have been growing rapidly seem



Fig. 57. Lamb afflicted with stiff lamb disease, which in this case was associated with a lack of vitamin E in the ration. (Courtesy, Dr. John Willman, Cornell University.)

to be especially susceptible. If death does not follow, the lambs will at least be severely stunted. Post-mortem examination shows that certain muscles have undergone degeneration, becoming whitish or yellowish grey in color.

CAUSE, PREVENTION, AND TREATMENT:

Dr. John Willman, of Cornell, is of the opinion that the nutritional type of "stiff lamb disease" is associated with a lack of vitamin E and that the trouble may be prevented by feeding good rations. There is no sure cure for affected animals, but a high vitamin-E diet seems to help certain cases. The Cornell work, however, was based on a ration high in cull red kidney beans; therefore, additional studies are needed with other rations.

Ketosis (or Acetonemia) in Cattle

Ketosis is a metabolic disorder—thought to be a disturbance in the carbohydrate metabolism—affecting cattle, sheep and milk goats in which there is an abnormal quantity of ketone bodies (acetone, acetoacetic acid, and betahydroxbutyric acid) in the blood, urine, and milk. In cattle, this condition is commonly referred to as acetonemia, whereas in ewes it is known as pregnancy disease. Though the clinical findings are similar in the case of affected animals in both species, it usually strikes ewes just before lambing. In cows, it is usually observed within the first six months after calving. Ketosis in cattle and sheep, therefore, will be discussed separately.

SYMPTOMS:

This malady is an important problem in the dairy industry. It seldom or never occurs in dry cows, steers, or bulls.

Affected animals show a loss in condition, a marked decline in milk production, and the production of a peculiar, sweetish, chloroform-like odor of acetone that may be present in the milk and pervade the barn.

CAUSE, PREVENTION, AND TREATMENT:

A dietary cause has long been suspected as a possibility, but conclusive experimental work on the disease is still lacking. Prevention consists of feeding a well-balanced ration. In addition, the opinion prevails that high-producing cows should have a source of readily available sugars, such as may be provided by adding one quart of molasses to the ration daily. The feeding of molasses or glucose is considered as both a preventive and curative measure. Effective clinical treatment of seriously affected animals consists of glucose injection by a veterinarian. Some veterinarians also use vitamin and mineral therapy in addition to glucose.

Ketosis (or Pregnancy Disease) in Sheep

Pregnancy disease of sheep is worldwide, and no section of the United States is free from the ailment. Farm flocks are more affected than range bands, the losses in the former sometimes running as high as 25 per cent. All evidence points to the fact that the disease is largely nutritional in origin.

SYMPTOMS:

The disease generally strikes during the last two weeks of pregnancy, and usually the affected ewes are carrying twins or triplets. Characteristic symptoms include grinding of the teeth,

dullness, weakness, frequent urination, and trembling when exercised—with the final stage being complete collapse, followed by death in 90 per cent of the cases.

CAUSE, PREVENTION, AND TREATMENT:

The specific cause of pregnancy disease is unknown, but it is attributed to disturbances in metabolism resulting from pregnancy, poor feeding, and lack of exercise. Prevention consists of (1) giving the ewes a well-balanced ration and plenty of clean, fresh water during gestation, (2) providing regular and moderate exercise during this period, and (3) following good management practices, including parasite control.



Fig. 58. Ewe with ketosis or pregnancy disease. The specific cause of this disease is unknown, but it is attributed to disturbances in metabolism resulting from pregnancy, poor feeding, and lack of exercise. (Courtesy, Dept. of Veterinary Pathology and Hygiene, College of Veterinary Medicine, University of Illinois.)

No entirely satisfactory curative treatment is known—though, if given in the early stages, it has been found that a half cupful of sugar or molasses fed three to four times daily is quite helpful in many cases. If affected ewes are able to lamb in the early stages of the disease, rapid recovery may be expected.

Grass Tetany (Or "Grass Staggers")

Grass tetany is a highly fatal disease of cattle characterized by lowered blood magnesium and calcium. It occurs most often within two weeks after animals have been turned out to good pasture. In this country, it has been found in Nebraska, Kentucky, Missouri, Iowa, Washington, and perhaps certain other areas. Grass tetany has also been reported in Holland, New Zealand,

and England. Although the dietary relationship is not known, the condition is definitely nutritional.

SYMPTOMS:

Nervousness, twitching of muscles (usually of head and neck), head held high, accelerated respiration, high temperature, gnashing of the teeth with abundant salivation—slight stimulus may precipitate a crash to the ground and, finally, death.

CAUSE, PREVENTION, AND TREATMENT:

The exact cause of the condition is still unknown, but it does appear to be nutritional. The trouble may be averted by not turning animals to pasture, but this is not a practical approach. Perhaps a full feeding of hay at night during the first two weeks of the pasture season may be helpful as a preventive measure. As the disease often runs a rapid course, there may not be sufficient time for treatment. Present approved treatment consists of an intravenous injection of a solution of calcium or magnesium salt by a qualified veterinarian.

Sweet Clover Disease

Sweet clover disease, a condition which appears principally in cattle and which rarely affects sheep and horses, is caused by the ingestion of improperly cured sweet-clover hays or silage and Lespedeza hays containing dicoumarol. A few cases have also been reported with animals on sweet clover pasture.

SYMPTOMS:

The most distinctive symptom of the disease is a loss of the clotting power of the blood. As a result, the blood gathers in considerable volume in different localized parts of the body, especially beneath the skin, so as to form soft swellings of varying size. Following injury or such surgical operations as dehorning, docking, or castration there may be serious or even fatal bleeding of affected animals. Fatal bleeding may also accompany parturition. The newborn calf also may have the condition at birth.

CAUSE, PREVENTION, AND TREATMENT:

The cause of the disease is in doubt, but it is usually produced only by moldy or spoiled hay or silage, though spoilage may not always be detected.

Prevention of sweet clover disease consists of the proper curing of any sweet clover hays or ensilage or Lespedeza hay, thus avoiding the feeding of any moldy or damaged products. The hazard may also be reduced by mixing the sweet clover with a rough-



Fig. 59. Calf with sweet clover disease. Note the collection of blood at the point of the left shoulder. (Courtesy, Dept. of Veterinary Pathology and Hygiene, College of Veterinary Medicine, University of Illinois.)

age of known wholesomeness (a dilution process, as it is sometimes designated). When questionable sweet clover is to be fed, it may be used more safely by alternating it with a better quality hay—especially alfalfa, which is very high in vitamin K—feeding each for about two-week intervals.

Treatment consists of removing the offending material. Usually affected animals will recover if given attention in time. The veterinarian usually gives the affected animal an injection of plasma or whole blood from a normal cow that was not fed on the sweet clover. Feeding alfalfa hay will also help in alleviating the condition.

Azoturia (Hemoglobinuria, Monday Morning Disease, or Blackwater) Of Horses

Azoturia is a disease which is peculiar to horses. It is directly connected with high feeding and with work following a period of idleness in the stall on full rations. The disease is seldom seen in horses at pasture and rarely in horses at constant work.

SYMPTOMS:

Symptoms include profuse sweating, signs of abdominal distress, urine discoloration, stiff gait and reluctance to move, and lameness. Finally, the animal goes down in the affected limbs, assuming a sitting position, and eventually falls prostrate on the side.

CAUSE, PREVENTION, AND TREATMENT:

The cause is generally attributed to faulty carbohydrate metabolism. It is thought that, during a period of rest when on high feed intake, glycogen is stored in the muscle. Heavy work following idleness breaks the glycogen down, flooding the mucles with lactic acid and producing the symptoms noted above.

Prevention lies in restricting the ration and providing daily exercise when the animal is not at work. Giving a wet bran mash the evening before an idle day or turning the idle horse to pasture are excellent preventive measures. When the disease makes its appearance, several hours of absolute rest and quiet is the best treatment. A veterinarian should be called as promptly as possible. While awaiting the veterinarian, heated cloths or blankets, hot water bottles, and comparable devices may be beneficially applied to the swollen and hardened muscles.

Heaves In Horses

Heaves is a chronic respiratory disease of the horse. While the exact cause is obscure, it is known that the condition is associated with the feeding of damaged, dusty, or moldy roughage.

SYMPTOMS:

This condition is characterized by difficulty in forcing air out of the lungs, resulting in jerking of the flanks (double-flank action) and coughing. The nostrils are often slightly dilated, and there is a nasal discharge. The cough—which is low, long and moist—is brought on easily.

CAUSE, PREVENTION, AND TREATMENT:

Most authorities agree that the main source of trouble with heaves is associated with the feeding of damaged roughage, especially dusty or moldy hay. Prevention consists of avoiding the use of damaged feeds.

There is no satisfactory treatment, though affected animals are less bothered if turned to pasture, if used only at light work, or if the hay is sprinkled lightly with water (or lime water) at the time of feeding.

Milk Fever

Milk fever affects milk cows, ewes, goats, and pigs—usually striking high-milk producing animals. It is one of the most common, widespread, and serious of the afflictions of dairy cows. It became especially prevalent with the development of the modern heavy-milking strains. The term "milk fever" is a misnomer, because the disease is not accompanied by fever, the temperature really being below normal.

SYMPTOMS:

The disease commonly occurs soon after parturition, generally affecting high-producing animals. It rarely occurs at the first calving. The first symptoms are loss of appetite, constipa-

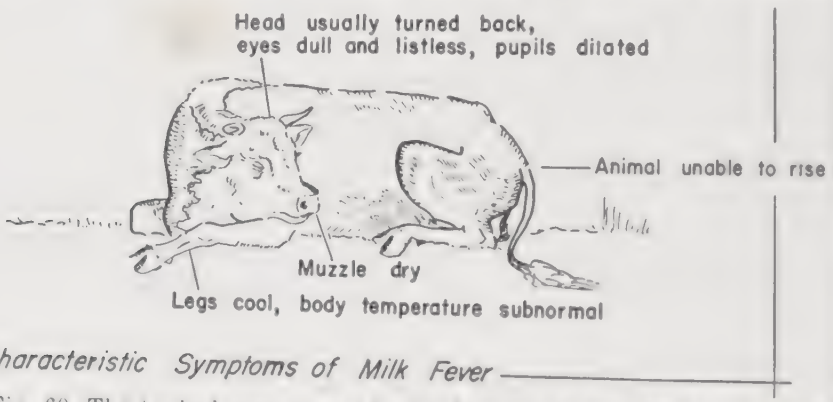


Fig. 60. The typical symptoms of milk fever in a cow. (Drawing by R. F. Johnson.)

tion, and general depression. This is followed by nervousness and spasms and finally collapse and complete loss of consciousness. The disease is also characterized by a tonic spasm of the muscles of the neck, giving the neck a distinct, lateral kink.

CAUSE, PREVENTION, AND TREATMENT:

Modern thinking is to the effect that the immediate cause of the attack is an acute fall in the blood calcium concentration, together with a possible unbalanced condition of other minerals. Many cases are also complicated with acetonemia. When a heavy-milking cow begins to form milk, the calcium, sugar, and other constituents of the blood are drawn out faster than they can be replenished. When the blood calcium falls below a certain level, paralysis develops.

No positive methods of preventing milk fever are known, though careful attention to the ration before and after parturition may be helpful. Though additional study is needed, some

have reported a certain degree of success in preventing the disease by injecting a calcium salt right after calving. Others appear to experience less trouble when the animals are only partially milked, rather than milked dry, following parturition.

Treatment, which is usually quite successful, consists of (1) having the veterinarian give intravenous therapy, or (2) inflating the udder with filtered air, the air being filtered in order to avoid introducing infection by contaminating the teat canal. The injection may vary, but usually it consists of about 500 c.c. of 23 per cent calcium gluconate, which is placed in the jugular vein. Sometimes, the injected solution is modified by the addition of dextrose, phosphorus, magnesium, and traces of cobalt. Although the air treatment is the oldest and perhaps still the most common method of treating milk fever, it should only be resorted to when a veterinarian is not available. It is accomplished by means of a sterilized milk-fever outfit, the udder being pumped up with air to cause a back pressure which keeps the blood from entering the udder. This usually gives quick relief, though it may be necessary to pump the udder up a second or even a third time. After the udder is distended until it is about the same hardness as a bicycle tire, the teats should be tied with tape to keep the air from escaping. The milk should not be removed from the udder before pumping.

Urinary Calculi ("Gravel" or "Stones")

Urinary calculi occurs rather frequently in cattle, sheep, and horses and also in man. Calculi are crystalline deposits of stone-like concretions in the urinary tract which almost always originate in the kidneys. Because of the gradual decrease in size of the opening of the urethra from the bladder to the penis and the distinct "S curve" (present in ruminants and swine but not in the horse) at the upper end of the penis, the concretions which enter the urethra are frequently blocked in forward passage, and urination is practically stopped.

SYMPTOMS:

The symptoms of urinary calculi include frequent attempts to urinate, dribbling or stoppage of urine, and pain or renal colic. Usually only the males of each species are affected, the females of the species being able to pass the concretions. Some of the stones may pass, so that the animal appears better at intervals, but affected animals seldom recover completely. When the stones are exceedingly large and relief is not secured, the distended

bladder may rupture, with death following. Otherwise, uremic poisoning may set in.

CAUSE, PREVENTION, AND TREATMENT:

The cause of urinary claculi is unknown, but it does seem to be tied up with nutrition.

Although experimental evidence is lacking, observation would indicate that urinary calculi occurs less frequently when animals are not too fat or on liberal rations. There also is less incidence of the disturbance when the animals are receiving an abundance

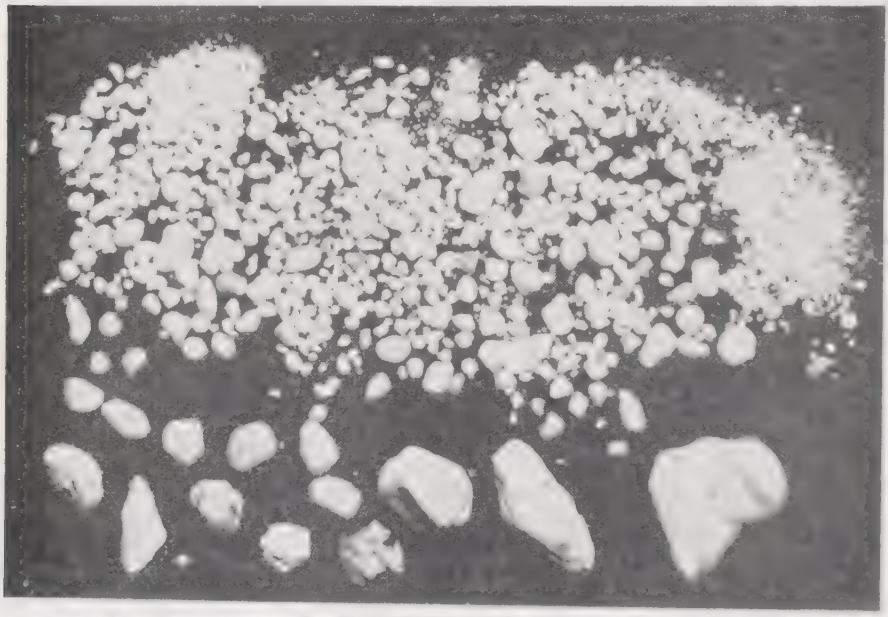


Fig. 61. Concretions or stones obtained from a $6,500 imported Shorthorn bull that died from urinary calculi. The cause of urinary calculi is unknown, but it does seem to be tied up with nutrition. (Courtesy, The State College of Washington.)

of water, succulent feed, an adequate amount of vitamin A, plenty of exercise, and a normal calcium, phosphorus, and magnesium intake. There also seems to be less urinary calculi when liberal quantities of good alfalfa hay are fed. Calculi occur in animals fed certain rations more frequently than in others.

Once calculi have developed, dietary treatment appears to be of little value. Surgery may save the animal, but such treatment will result in bulls becoming non-breeders.

If severe outbreaks of urinary calculi occur in fattening steers or feeder lambs, it is usually well to dispose of them on the market if they are carrying acceptable finish.

Bloat

Bloat is a distension of the first stomach, the rumen, with gas. It is a troublesome digestive disorder of cattle and sheep that is often the cause of heavy losses. When caused by overeating or type of feed, it may be considered as nutritional. It is generally agreed that there are two types of acute bloat, namely (1) that type in which the free gas is found in one or more large pockets in or on the ruminal mass, and (2) foamy bloat in which the gas is held in the ingesta as a foam.

SYMPTOMS:

The presence of bloat is easily detected by a pronounced swelling of the left side in the region in front of the hip bone. If the condition is severe and relief is not forthcoming, death may follow.

CAUSE, PREVENTION, AND TREATMENT:

Bloat is caused by an excessive rumen accumulation of gases, probably formed to a large extent by bacterial action. Although the cause of bloat is not fully understood and there are many conflicting theories, most investigators agree that bloat is due to an upset in the normal mechanism for expelling gas. The failure of the belching mechanism probably has a complicated etiology which includes nutrients in the feed (e.g., high protein of a given kind), abnormal or unbalanced flora, toxic gas (e. g., H_2S) and other agents (e.g., histamine formation).

No sure way of preventing bloat is known, and no treatment is successful under all circumstances. However, experienced stockmen generally agree on the following observations:

1. Animals are more likely to bloat on legume than on grass pastures. For this reason, grass-legume mixed pastures (with at least 50 per cent grasses) are preferable to straight legumes. With very valuable animals, straight grass pastures are often desirable.

2. Many practical stockmen feel that the bloat hazard is reduced by mowing alternate strips through legume or legume-grass pastures, thus allowing the animals to consume the dry forage along with the pasture. Others keep in the pasture a rack well filled with dry hay or straw.

3. Young, lush grasses or legumes in the pre-bloom stage are more likely to produce bloat than more mature grasses.

4. Pastures that are wet with dew or light rain, or that have been frosted, are more likely to cause bloat.

5. Animals are more likely to bloat if they take on a rapid fill from a relatively empty start. For this reason, it is good practice to give hungry animals a fill of dry hay before turning them to a legume pasture. Also, overnight pasturing or feeding of sudan is effective in preventing bloat when animals are grazing alfalfa.

6. If possible, after animals are once turned to pasture, they should be left there continuously. If the animals must be removed overnight or for longer periods, they should be filled with dry roughage before they are returned to the pasture.

7. Alfalfa hay and barley appear to be associated with a higher incidence of bloat than many other feeds.

8. There seems to be an area difference, some regions having more bloat than others. This may be due to soil fertility or some such factors.

9. Some families of animals are more susceptible to bloat than others.

10. Certain fibrous feeds seem to aid in preventing bloat, perhaps because of the rough, serrated edges and higher fiber content. Thus the feeding of sudan hay, oats, and dried beet pulp appears to lessen the incidence of bloat.

11. Animals on heavy feed are more likely to bloat than those that are merely being maintained.

12. Ruminants bloat when choked.

Time permitting, severe cases of bloat should be treated by a veterinarian. Puncturing of the paunch with a trocar and cannula should be a last resort. The trocar is a sharp-pointed instrument encased in a sheath, known as the cannula. In cattle, the insertion is made about four inches forward from the left hip and the same distance below the edge of the loin. In sheep, the incision should be at a corresponding location, smaller size considered—which means about midway between the posterior rib and the hip bone. The instrument should be pointed toward the right front leg and then inserted by striking its handle with the palm of the hand. Withdraw the trocar, leaving the hollow cannula through which the gas escapes. In the event a trocar and cannula are not available and death is imminent, the incision may be made with a sharp knife.

If a veterinarian is not readily available or when the bloat is not too severe, the following home remedies may prove helpful in stopping fermentation or inducing belching:

1. Keep the animal on its feet and moving; gas is more likely to be expelled in this manner.

2. One-half to one pint of mineral oil may be given, but be certain not to pour the oil down the trachea (a mature cow may be given the full amount, with a mature sheep receiving about one-fifth this dosage.)

3. One tablespoonful of turpentine and one tablespoonful of aromatic spirits of ammonia diluted in a quart of water often will bring good results (a mature cow may be given this full dosage, with a mature sheep having about one-fifth this amount).

4. Placing a stick in the animal's mouth in the form of a bit or gag often induces belching. However, one should never try to dislodge obstructions in the esophagus with a stick, buggy whip, or other similar object.

5. A hose may be forced down the gullet and into the pauch, but one should be very cautious lest it go into the trachea (windpipe). Great care must be exercised, for kinks in the esophagus during bloat make passing of the tube difficult or impossible.

6. Massaging of the left side may be an effective adjunct in reducing bloat, but one should avoid "rough stuff."

7. In the event of foamy bloat, the only recourse in handling a very bad case at the present time is a delicate operation performed by a veterinarian in which the rumen (paunch) is cut open and the foamy contents removed.

Upon recovering from a case of bloat, the feed should be materially reduced for three or four days and the animal should be inspected at intervals.

Founder

Horses, cattle, sheep, and milk goats are subject to founder, but the omnivorous pig is not susceptible, nature having endowed the latter with the ability to readily unload his stomach by the act of vomiting. Founder is a serious ailment of the fleshy laminae of the feet. All feet may be affected, but the front feet are most susceptible.

SYMPTOMS:

Extreme pain and fever (103° to 106° F.) are the chief symptoms. Affected animals are very reluctant to move, and when they are compelled to do so, they give evidence of excruciating pain. If the condition is neglected, chronic laminitis will develop, resulting in a dropping of the hoof soles and a turning up of the toe walls.

CAUSE, PREVENTION, AND TREATMENT:

Founder is most often caused by overeating, though it may also result from overdrinking (especially from consuming too much cold water when hot) or by inflammation of the uterus following parturition. Prevention in so far as possible consists of avoiding those conditions which cause the disease.

Pending arrival of the veterinarian, the attendant should stand the animal's feet in a cold-water bath. Unless the animals are quite valuable, it is usually desirable to dispose of them following a case of founder.

Colic in Horses

Colic is the name generally given to symptoms which horses exhibit when they have indigestion accompanied by severe pain. It is primarily a disorder of function of the stomach, large intestine, and or the caecum, usually resulting from improper feeding or poor feed. This disturbance is peculiar to horses because of their small stomach, complicated arrangement of the intestines, and inability to vomit except through the nose.

SYMPTOMS:

The afflicted horse exhibits signs of excruciating pain; and, depending on the type of colic, other manifestations are distended abdomen, increased intestinal rumbling, violent rolling and kicking, profuse sweating, constipation, and refusal of feed and water.

CAUSE, PREVENTION, AND TREATMENT:

Colic may result from any one of a multitude of circumstances. Feeds that the animal is unaccustomed to, sudden changes in the ration, rapid eating, imperfectly cured or damaged feeds (moldy feeds, frozen silage, etc.). Working the horse too soon or too hard after feeding, or gorging on water, especially when warm, are all errors that are likely to cause digestive disturbances.

Proper feeding, working, and watering will usually prevent colic. When a case of colic is discovered, the veterinarian should be called at once. To reduce danger of inflicting self injury, the animal should be placed in a large, well-bedded stable. A slow walk will sometimes ease the pain and help in avoiding injury to the animal. In no case should the inexperienced laymen attempt to drench the horse.

Selenium Poisoning ("Alkali Disease")

In certain regions of the West—particularly certain areas in South Dakota, Montana, Wyoming, Nebraska, Kansas, and per-

haps other states in the Great Plains and Rocky Mountains—some soils contain the element selenium. Plants grown on these soils may contain sufficient quantities of this element to be toxic when consumed by animals. All species of farm animals are affected, and serious losses may result from the use of feeds containing selenium.

SYMPTOMS:

Chronic selenium poisoning results in loss of hair from the mane and tail in horses and from the tail in cattle and a general loss of hair in swine. In severe cases, the hoofs slough off, lameness occurs, food consumption decreases, and death may occur by starvation.



Fig. 62. Hind feet of cow afflicted with selenium poisoning. In severe cases, the hoofs slough off. (Courtesy, Alvin L. Moxon, South Dakota State College.)

CAUSE, PREVENTION, AND TREATMENT:

The disease is caused only by animals consuming certain plants grown on soils containing selenium. Control measures for the disease are largely based on prevention. The only safe procedure is to abandon affected areas, because crops produced on such soils constitute a menace to both animals and man. No sure and successful treatment of affected animals has been developed, though arsenic ingestion has been found experimentally to counteract the toxic effects. It has been found that (1) high fat-low protein or (2) high-protein diets greatly delay and decrease the frequency of selenosis.

Fluorine Poisoning (Fluorosis)

Since fluorine is a cumulative poison, long-continued consumption of relatively small quantities produces chronic fluorosis in all classes of farm animals and poultry. In large doses, fluorine is a violent poison. The greatest danger from fluorine poisoning in livestock comes from the use, in mineral mixtures, of phosphates which are high in fluorine. The water in certain areas, namely in parts of Arkansas, California, South Carolina, and Texas, has been reported to contain excess fluorine.

SYMPTOMS:

The general symptoms of chronic fluorine poisoning are abnormal teeth (especially mottled enamel) and bones, stiffness of joints, loss of appetite, emaciation, reduction in milk flow, diarrhea, and salt hunger.

CAUSE, PREVENTION, AND TREATMENT:

Fluorine poisoning results from ingesting excess quantities of this mineral through either the feed or water. Although the element is not taken up by the roots of plants, the leaves may hold fluorine containing residues (e.g., through spreading a phosphate fertilizer high in this mineral). Prevention consists of avoiding the use of feeds, water, or mineral supplements containing excessive fluorine. Any damage may be permanent, but animals which have not developed severe symptoms may be helped to some extent, if the source of excess fluorine is eliminated.

Poisonous Plants

Poisonous plants are found in all parts of the United States, but the heaviest losses therefrom occur on the western ranges. Larkspur, whorled milkweed, loco-weed, and halogeton are among the most destructive. Stock poisoning from plants is more frequent on the ranges of the West than in other sections of the United States because (1) quite naturally, there has been less cultivation and destruction of poisonous plants in range areas, and (2) the frequent overgrazing on the western ranges has resulted in the elimination of some of the more nutritious and desirable plants, and these have been replaced by increased numbers of the less desirable and poisonous species.

WHY ANIMALS EAT POISONOUS PLANTS:

Fortunately, poisonous plants are usually less palatable than other species. Thus, when animals are allowed free choice, they

usually select the more desirable forage and avoid the plants that are toxic. In general, one or more of the following conditions usually prevail as predisposing factors when animals eat poisonous plants:

1. When poisonous plants (or seeds) become mixed with hay (or grain), it is difficult for animals to separate the good feed from the toxic material.



Fig. 63. Cow with snakeroot poisoning. Marked weakness results in the "trembles" characteristic of this condition. (Courtesy, Dept. of Veterinary Pathology and Hygiene, College of Veterinary Medicine, University of Illinois.)

2. When overgrazing has reduced the available supply of the more palatable and safe vegetation, animals may, through sheer hunger, consume the toxic plants.

3. Very hungry animals, such as animals that have been recently shipped or trailed long distances, will not selectively graze in the normal manner. Thus excessive losses often follow such conditions.

CONTROLLING LOSSES FROM POISONOUS PLANTS:

The most effective control measures include the following:

1. Eradication of the toxic plants, if at all possible.
2. Preventing overgrazing.

When a sufficient supply of desirable forage is available, less-toxic material will be eaten.

Usually, plant-poisoned animals are not discovered in sufficient time to prevent loss. If the damage has not already been done, treatment is usually directed toward the elimination of the toxic substance which still remains in the digestive tract. Prevention is always the best treatment.

The list of poisonous plants is so extensive that the writer will not make any attempt to discuss each of them. Those who are interested in further pursuing this subject are referred to the specific books and bulletins relative to poisonous plants.

NUTRITION RESEARCH OF THE FUTURE

Research in the field of animal nutrition has brought amazing results. In fact, it has been well said that we are gradually learning to feed our children as well as our animals. Despite this remarkable progress, it is recognized that a combination of forced production, feeds produced on depleted soils, and the purification of feeds has created many problems. It is encouraging to note, however, that new frontiers in nutrition research are on the horizon.

Atomic research has opened up the possibility of approaching problems of nutrition and metabolism that were considered unsolvable prior to World War II. Perhaps we shall now be in a position to study the particular paths that glucose, amino acids, vitamins, and hormones follow in the animal body until they are either incorporated in the tissues or excreted in milk, urine, or expired air.

It is doubtful that all the essentials of an adequate diet for any given species of animals have been discovered, especially all of those things essential to growth and reproduction. It is recognized also that there is need for additional information about the amounts of some of the recently discovered nutrients required by farm animals and the quantities of these nutrients available in common feedstuffs. Then there are the myriad and perplexing problems of interrelationships of nutrients, of intestinal synthesis, of nutritional changes in processing, and of the effect of dietary nutrients on the quality of product produced—all of which are deserving of further investigations.

Practical producers are fully cognizant of the all too frequent short productive life of animals (in terms of milk, eggs, wool, or young). The rearing of animals from birth to the

productive stage represents an initial cost which, for greatest returns, must be spread over a long life of profitable production. In order to obtain a longer and more profitable productive life in animals, there is need, therefore, for long-time nutrition studies designed to determine whether there is an optimum growth rate from birth to maturity.

Are young animals being forced for too rapid growth, early maturity, and production? At the present time, the answer to this question is unknown.

During World War II, the American public became increasingly conscious of fortified human foods. It was recognized that such feeds as wheat bran and meat scraps had made better pigs and chickens, but the refined flour and diversion of liver into animal feeds had made poorer human beings. Based on the store of available knowledge from nutrition research, much of which came via the animal route, improved human health was sought through the wider use of such fortified human foods as iodized salt; milk enriched with vitamin D; flour, bread, and certain cereals enriched with B vitamins and minerals; and margarine fortified with vitamin A. Iodine-fortified salt has long been a standard mineral product for stock in iodine-deficient areas. More recently, salt has been fortified with cobalt, copper, and other trace minerals for use in those areas where such deficiencies exist. Now forms of stabilized vitamin A are on the market, and it is quite likely that these products will come to fill a real need for stock in many range areas of the West.

Finally, when new knowledge in animal nutrition becomes available—as some of the gaps are filled in—it is important that any erroneous practical recommendations be corrected and that wider application be made of the newer scientific findings. Stockmen need to practice what is already known. But this is a scientific age, and it is perhaps fair to say that never before has there been wider application of the available knowledge in the field of animal nutrition. Our greatest need, therefore, is to recognize the limitations in our present knowledge and to open up new frontiers for the benefit of the livestock industry and human welfare.

REFERENCES

Further information relative to feeding as applied to each of the respective classes of livestock is presented in the following books by the same author and the same publisher as *Animal Science:*

Beef Cattle Husbandry

Sheep Husbandry

Swine Husbandry

Horse Husbandry

CHAPTER IV

LIVESTOCK BARNS, SHELTERS, AND EQUIPMENT[1]

Properly constructed and arranged buildings and equipment are an asset to the farm or ranch. They increase animal production, make for feed efficiency, conserve crops and manure, provide comfort for man and beast, and add to the beauty of the farm landscape. In serving these purposes, it is not necessary that buildings and equipment be either elaborate or expensive.

Because of variations in climatic conditions, sizes and types of enterprises, and systems of management, the writer does not propose to present detailed building and equipment plans and specifications. Rather, it is desired merely to convey suggestions regarding some of the desirable features of buildings and equipment in use in various parts of the country. It is suggested that plans and specifications for a particular locality be obtained by studying successful buildings and equipment on neighboring farms and ranches or by consulting the local county agricultural agent or FFA instructor or writing the college of agriculture in the state.

LOCATION OF FARM OR RANCH HEADQUARTERS

When planning an entirely new farm or ranch headquarters, the choice of location for the buildings is the first consideration. Likewise, when appraising the desirability of an existing headquarters, the same factors should be considered. These are:

1. **Water Supply**—Water should be available and plentiful. With the availability of electricity and automatically operated pumps, many farmers and ranchers can locate the headquarters farther from the source of water supply when it is desirable to do so to obtain other advantages.

[1]The author acknowledges his indebtedness to the following authorities who reviewed Chapter IV: Professor June Roberts, Head, Department of Agricultural Engineering, State College of Washington, Pullman, Washington; Professor J. C. Wooley, Head, Department of Agricultural Engineering, University of Missouri, Columbia, Missouri; Professor K. B. Huff, Department of Agricultural Engineering, University of Missouri, Columbia, Missouri, and Professor C. H. Zuroske, Assistant Agricultural Economist, Department of Agricultural Economics, State College of Washington, Pullman, Washington.

2. **Topography.**—The topography should be high and level with no abrupt slopes. A relatively level area requires less site preparation, thus lowering building costs.

3. **Drainage.**—The soil should be porous and the slope gentle, for this makes for dry corrals and lots. Animal health is much more easily maintained when the yards and buildings are well drained; and the work of the caretaker is more pleasant and easier under such conditions.

4. **Size and shape.**—The area for the headquarters should be of adequate size, usually from two to five acres, and nearly square in shape. With further mechanization, smaller farmsteads are now needed than in the era when horses were extensively used. In general, the tendency is to have too large a farmstead; this adds to maintenance and weed-control costs and keeps valuable land out of production.

5. **Soil type.**—A good fertile soil is desirable for the garden and yard.

6. **Accessibility to fields.**—In general, centrally located headquarters have the advantage of efficiency of field work. Headquarters so located also facilitate the movement of stock to and from all fields with the least inconvenience.

7. **Roads.**—It is preferable that the headquarters be located near an all-weather road that is well maintained, but one should avoid having the farmstead on both sides of a road.

8. **View.**—A scenic view, especially from the living side of the house, makes for a "heap of living."

9. **Sun exposure and wind protection.**—The farm or ranch headquarters should be located to obtain the maximum sun exposure in the north and the minimum sun exposure in the south and protection from strong prevailing winds.

10. **Electricity.**—If possible, the headquarters should have access to a power line.

11. **School and churches.**—The farm or ranch family should have convenient access to a good school and the church of their preference.

12. **Telephone.**—Farming or ranching is a business, and it is difficult to conduct any kind of modern business without access to a telephone. The headquarters should be near a well-maintained telephone line.

13. **Mail route.**—The headquarters should be served by an established mail route, which will provide daily communication with the outside.



Fig. 64. An attractive Iowa farmstead arrangement. Well-arranged and well-kept farm buildings are the trademark of a successful livestock farm. (Courtesy, The Corn Belt Farm Dailies.)

14. **Service facilities.**—The headquarters should be served by school busses, delivery services, and cream or milk routes.

15. **Erosion control.**—On those farms or ranches in which soil erosion is a problem, it is desirable that the headquarters and fields be located to permit contour farming.

16. **Vegetation.**—Natural shade, trees for windbreaks, and a well-sodded area are valuable attributes.

FARMSTEAD ARRANGEMENT

In planning a new farm or ranch headquarters or in altering an old one, buildings, fences, lots, trees, etc., should be added according to an established master plan; for, once constructed, buildings are difficult and expensive to move. In general, for conservation of space and time, the barn and other service buildings should be located around a central court and should be so arranged that most of them can be seen from the house. In arriving at the best arrangement—which means the location and arrangement of individual buildings within the site—the farmstead cannot and should not be modeled after one popular pattern. Consideration should be given to the following pertinent factors:

1. **The house location comes first.**—As the farm or ranch house is the headquarters or office of the farm business as well as a home, its location is of greatest importance in farmstead arrangement. The ranch house should be located: (1) on a high area which is well drained away from the house and will command a view of other buildings as well as one or more scenic views; (2) where it is easily accessible; (3) in the direction of the prevailing winds but sheltered from strong winds; (4) to

obtain the maximum of sunlight in the north and a minimum of sunlight in the south; (5) with access to either the front or back door but with best access to the front door; (6) where there is adequate yard which can be well landscaped; and (7) approximately 150 feet from the road.

2. **Orientation.**—Fortunately, the farm or ranch headquarters need not be oriented with the compass. Although in general the farmstead plan will be developed to present the front to the road, most buildings can be turned, quarter-turned, or reversed, as may be necessary to take advantage of the prevailing winds, sunlight, view, etc. In general, livestock barns are placed with the long axis north and south, whereas, when possible, livestock sheds in northern areas are faced to secure direct sunlight and yet to face away from the direction of the prevailing winds. In the South, sheds are usually oriented for maximum shade and storm protection.

3. **Direction of wind.**—The house should be located on the windward side of the headquarters, with special consideration given to summer winds. Swine barns should be located at the greatest distance from the other farm buildings, especially from the house and dairy barn, and so that the prevailing winds will not blow from the swine barn to the house. Unless hills form a natural windbreak, it is desirable to arrange suitable tree plantings for this purpose. Usually, a tree windbreak is located 75 to 150 feet from the buildings to be protected, with three to seven rows of trees 20 to 75 feet wide.

4. **Efficiency.**—The buildings should be located so as to require a minimum of walking when doing the chores. This means that those buildings in which the most time is spent—such as the dairy barn, poultry house, and machine shop—should be closest to the house and that the buildings should be near enough together to permit efficiency of labor without making a fire hazard. Likewise, animal barns should be convenient to feed lots and pastures.

5. **Corrals and lots.**—The buildings and their adjacent corrals and lots should be arranged so that the buildings are accessible without walking through feed lots and corrals.

6. **Fire protection.**—Farm buildings should be far enough apart so that fire will not spread easily from one building to another. In general, this means at least 100 feet apart in the case of large buildings. In acquiring added fire protection through spacing buildings further apart, one should avoid extreme dis-

tances that will mean inefficiency in operation; fire insurance is probably cheaper than labor.

7. **Appearance.**—Careful attention to the headquarters arrangement can add to the attractiveness of the entire unit. Manure piles and unsightly objects should not be visible from the main highway or house; shrubbery and trees should be planted to screen unsightly objects; fences and buildings should be repaired and painted regularly; and yards, driveways, and corrals should be kept free of rubbish, scattered farm machinery, etc.

8. **Gates and lanes.**—The adoption of larger machinery has necessitated wider gates and lanes than have been commonplace in the past. Often the wider lanes can serve as pasture as well as roadway.

REQUISITES OF LIVESTOCK BUILDINGS

Each farm or ranch is different, and the type and size of buildings will vary accordingly. Among the factors determining the type and size of buildings are: (1) kind and fertility of the soil, (2) available markets, (3) size of farm, (4) tenant or owner operation, (5) kind and amount of livestock and crops to be grown, (6) personal preference, (7) climatic conditions of the region, and (8) storage requirements. Thus the specific requisites of animal buildings will vary according to the needs of the region, state, community, and individual farm or ranch. There are, however, certain general requirements of animal buildings that should always be considered; and it is with these that the ensuing discussion will deal. Once buildings are constructed, there is a definite limit to the changes that can be made in remodeling. Consequently, it is most important that very careful consideration be given to their initial design.

Utility Value

First and foremost, buildings should have utility value. That is, they should be designed so that they will best serve their intended purpose. Generally, it may be said that the chief purpose or function of livestock buildings is to make it possible for animals to convert plants into more nutritious products. They should be constructed with this and other utility purposes in mind. To accomplish this, it is important that the man who is to use the building—the farmer or rancher—have the most to say about the design, provided that the design is well planned.

Provide Protection From the Elements

Livestock barns and shelters should provide protection from rain, snow, sun, and wind. Hogs, dairy cattle, and poultry have less resistance to weather changes than other classes of farm animals. It is important, therefore, that their quarters provide desirable and uniform temperature.

Protect Newborn Animals

Young calves, lambs, pigs and colts are "animal babies" and must be protected as such. Suitable buildings make it possible to save more newborn animals.

Attractiveness

Any structure that has utility value and is erected in good proportions and in harmony with the natural surroundings will add to the value of the farm or ranch and the general enjoyment of rural living. Attractive buildings also add materially to the sale value of farm or ranch property.

Durability

Livestock barns and shelters should be adequately durable to stand firm against wind and weather and to last for a sufficient span of time without excessive maintenance cost, but they need not be so expensively or permanently constructed that there is danger of their becoming obsolete before being worn out. Thus it is noteworthy that many a horse barn throughout the country —with the mechanization of farms and ranches—is either idle or has been remodeled, after a fashion, for the storage of the tractor.

Income tax authorities recognize the need for replacing farm buildings with new and modern structures. Thus a barn depreciated at the rate of 5 per cent annually is entirely written off the books in twenty years. In general, farmers and ranchers assume that the useful life of a building will average about forty years.

Reasonable Construction and Maintenance Cost

If buildings are to be practical and economical, there must be reasonable construction and maintenance costs. Stated differently, livestock barns and shelters must be paid for out of the enterprises they house, if desirable economic relationships are to be maintained. In addition to the practical aspects, however, certain intangible values accrue from having good buildings, such as the pride and satisfaction derived in caring for animals under such circumstances, reduced hazards, and, in the case of purebred

herds and flocks, the advertising value that accompanies an attractive set of buildings.

Dryness

Buildings should be constructed to assist in providing a reasonably dry bed for animals. This means that the barn or shelter should be located on high ground with drainage away from the building and that, except in dry areas, the structure should be provided with eave troughs and down spouts which empty into a tile line draining away from the building. Proper ventilation and direct sunlight also aid materially in providing dry bedding. In open sheds, it is important that there be sufficient depth to assure dryness.

Well Ventilated

Ventilation refers to the changing of air—the replacement of foul air with fresh air. Livestock barns and shelters should be well ventilated, but care must be taken to avoid direct drafts. Animals cannot do well in poorly ventilated stalls or sheds. If a choice must be made between warmth and ventilation, secure the latter. The primary purposes of ventilation are to remove excess moisture and remove foul odors. A desirable ventilation system accomplishes these objectives with a minimum temperature variation inside the building.

Ventilation may be secured by various systems. The simplest method usually consists of one or more of the following: (1) open shed, (2) open doors, (3) windows that open inwardly from the top, or (4) building or stall partitions left slatted or open at the top. A more complete method of ventilating tight buildings consists of a system of intake and outtake flues operated on the basis of either gravity or forced ventilation. Whatever the system, proper ventilation is one in which the foul air is drawn off and harmful humidity conditions are eliminated without excess heat loss or creation of drafts.

Well Lighted

Proper lighting is essential for visibility and the convenience of the caretaker. A well-lighted building may be obtained in either of three ways: (1) through an open shed or door arrangement, (2) by providing adequate windows, (3) by artificial lights, or (4) through a combination of the previous three ways as is usually the case.

Direct Sunlight

Direct sunlight is a powerful germicidal, and arrangements should be made to obtain its benefits. An open shed or door arrangement is the best means of securing direct sunlight.

Sanitary

Sanitation is essential for disease prevention and parasite control. This means that livestock barns should be constructed so that they may be easily cleaned, thoroughly disinfected, and free from vermin. Sanitation is also promoted structurally by providing for direct sunlight and elimination of moisture. Smooth walls and hard-surfaced floors are the most satisfactory from this standpoint. It must be recognized, however, that hard-surfaced floors are hard on animals, especially cattle, sheep, and horses.

Easily Cleaned

A barn or shelter which is arranged so that it may be easily cleaned is more likely to be kept in a sanitary condition. Construction that will permit the operation of a power-operated manure loader or a tractor with a blade on the front or back, in addition to such things as smooth walls and floors, are definite assets from the standpoint of ease in cleaning.

Proper Provision For Manure Disposal

Large drive-through doors and adequate ceiling height are essential for the operation of a labor-saving manure loader. In general, a minimum ceiling height of nine feet is recommended when it is planned to use a power-operated manure loader. There should also be provision for a manure pit, for this conserves the fertility value of the manure and makes for greater convenience.

Convenient

Livestock buildings should be constructed to furnish the greatest possible convenience, which means less steps and less man hours. This means that attention should be given to the most convenient arrangement for feeding, watering, and bedding the animals and for cleaning of barns. Among the most important points to be considered are the locations of the silo, water tanks, feed rooms or bins, hay chutes, driveways, feed alleys, stalls, doors, and windows and the arrangement for removing manure with a minimum of labor. Greater convenience usually means that one man can and will care for more animals, and this means greater profits. It is significant to note that an hour saved each day is equivalent to eliminating a full month's work in a year.

Adequate Space for Animals

Livestock barns and shelters should be of adequate size to accommodate the existing herds and flocks, expected young stock, and any contemplated early expansion in operations.

Adequate Space for Feed and Bedding Storage

In arriving at the space needs for feed and bedding storage, consideration should be given to: (1) the crop productivity of the farm, (2) the size of animal population to be maintained, (3) the management practices, and (4) the length of the winter feeding period. The proper storage of hay or grain, in a barn that keeps out rain, means more tons of sound, properly cured roughage or grain for feed.

Multiple Usage

For greatest use, buildings should be designed to have multiple usage; that is, to serve more than one type of farm enterprise. Without doubt, this is one of the main reasons why an open shed is so popular; the use of a structure of this type is sufficiently flexible to accommodate cattle, sheep, hogs, or horses, or it may serve for machinery, feed, and bedding storage.

Flexibility of use is especially important on tenant-operated farms; and, after all, nearly one-half of all the farms in the United States are tenant operated.

Minimum Fire Risk

The principal causes of fire losses in farm buildings are smoking, spontaneous combustion (usually from the heat generated by moist hay or forage), lighting, defective flues, sparks on roof, faulty wiring, ignition caused by accidents with equipment, trash fires, gasoline, and matches. The structural safeguards against fire include tile-lined flues, spark arrestors on chimneys, fire-resistant or fire-proof shingles, masonry construction, approved wiring that is inspected at intervals, approved installations of equipment, lightning protection in those areas where thunderstorms are frequent and intense, and "no smoking" signs which are observed. In addition to these precautions, exit doors should be provided so that animals may be removed from the building quickly in case of fire.

Safety

In the construction of livestock buildings, it is important that safety features be given consideration. For example, doors and ceilings should have adequate height; doors should be of

sufficient width; door sills should be low or omitted; and paved lots should not be dangerously smooth and slick.

Rodent Control

Livestock barns, and especially the feed storage parts thereof, should be constructed to provide the maximum protection against rats and mice. This is important both from the standpoint of feed conservation and disease prevention.

Surrounded by Suitable Corrals or Lots

Animal buildings should be provided with adjacent, well-drained, safe, durably fenced, and attractive corrals or lots. In small lots and in muddy areas, the pavement is recommended. If the entire corral or lot is not surfaced, it will be more helpful to at least pave a strip 15 feet wide in front of feed racks and around watering tanks. It is recommended that small corrals or lots be fenced with plank or poles. For larger yards, heavy wire fencing—sometimes with the wire doubled—and heavy posts set 8 to 10 feet apart may be used. Barbed wire fences are hazardous when used to confine animals in small yards; many an animal has been injured and made useless through such an arrangement.

Near Water

Water may be piped a considerable distance, but it is important that most barns or shelters either have water in the building or in the lots adjacent thereto. When separate and long pipelines are needed to serve livestock in rotation fields, tank wagons for hauling water may be more economical than pipelines. Water is also important from the standpoint of providing fire protection. For that purpose, there should be adequate volume and pressure.

Modify Extreme Temperatures

Good livestock buildings should make for a uniform temperature to provide greater comfort to both man and beast. In order to accomplish this requisite, buildings in northern areas are constructed for warmth in the winter; whereas in the South they are made cool for summer. Fortunately, nature has provided warm coats for most animals, and it is not necessary that they have exceedingly warm buildings, although such shelter is needed for the newborn offspring. In no case should warmth of a building be obtained at the cost of poor ventilation.

Keep Proper Humidity

Humidity refers to the amount of moisture in the air. The air inside animal buildings picks up moisture from respiration

and excrement. When the humidity of a building is high, the evaporation from the surface of the body practically ceases. This causes a sensation of warmth in the summer and coldness in the winter. When there is a difference of several degrees between inside and outside temperatures, the moisture condenses on the cold surfaces. In freezing weather this condensation forms frost. Condensation on the walls or other surfaces is evidence of unsatisfactory moisture conditions. Such condensation is objectionable because it is harmful for animals to go from a moist, warm barn into the cold outside air and because the excess moisture causes the structure to decay or deteriorate.

Experimental studies indicate that a 1000-pound cow breathes into the air approximately 10 pounds of moisture per day. Thus, from a herd of forty-two cows there would be given off 420 pounds or about 50 gallons of water per day. This amount of moisture must be removed daily in order to keep the barn free from dampness, thus necessitating proper ventilation.

Strawlofts in sheds or one-story barns and haymows in two-story barns reduce moisture condensation and frosting on the ceiling.

Properly Insulated

Proper insulation, which slows up the passage of heat, is desirable in the summer as well as in the winter. In the winter, it helps to hold the heat within the building, while in the summer it tends to prevent the heat from entering the structure.

Adapted to Present and Future Needs

In building a livestock barn or shelter, the farmer or rancher should give consideration to present needs and future plans, the present and potential production, and the various uses for which the barn is needed now and in the future. Thus, in constructing a barn, it is desirable that it be of a size that will meet the existing conditions and be so built as to permit the erection of additions without disturbing the convenient arrangement or without tearing down any part of the structure.

Protect Animal Health

Animal barns and shelters should provide healthful indoor living conditions for the occupants. This is most important, for healthy animals are the profitable and efficient ones.

REQUISITES OF LIVESTOCK EQUIPMENT

Generally speaking, livestock equipment refers to structures other than barns or shelters used in the care and management of animals. Much of this equipment is portable.

The size and design of livestock equipment may differ; that is, not all hay racks or self-feeders, for example, are the same. Yet there are certain fundamentals of livestock equipment that are similar regardless of the kind of equipment, the design, or the size. These requisites are:

1. **Utility value.**—Equipment should be useful, practical, and efficient.

2. **Simple construction.**—As most livestock equipment is homemade, simple construction is essential.

3. **Durable.**—Livestock equipment receives rough use. Thus it should be strongly and durably built.

4. **Dependable.**—Livestock equipment should be dependable, so that it will function without getting out of order.

5. **Low initial cost and upkeep.**—Like animal barns and shelters, livestock equipment must be paid for out of animal profits. It is important, therefore, that it have a low initial and upkeep cost.

6. **Movable.**—Equipment that is used away from buildings should be movable. Bunks, racks, and self-feeders should be built on skids so that they may be moved from one lot to another.

7. **Accessible.**—Stationary or less-portable equipment, such as stocks and dipping vats, should be readily accessible.

8. **Save feed.**—Much grain and hay may be saved when fed in properly constructed equipment. When such equipment is used, the animals clean up grain and hay and cannot throw or root it out of the feeder.

9. **Reduce labor.**—Modern equipment, such as large self-feeders and large hay racks that require infrequent filling, reduces the labor required in feeding operations.

10. **Conserve manure.**—Feeding equipment may be either located in the barn or feed yard from whence the accumulated manure is hauled directly to the fields or is placed in the manure pit. Or, by carefully moving the feeding facilities about in the fields, the fertility may be scattered where it is most needed.

RECOMMENDED MINIMUM WIDTH OF SERVICE PASSAGES

In general, the requirements for service passages are similar, regardless of the kind of animals. Accordingly, the suggestions contained in Table 9 are equally applicable to cattle, sheep, swine, and horse barns.

TABLE 9

RECOMMENDED MINIMUM WIDTHS FOR SERVICE PASSAGES

Kind of passage	Use	Minimum width
Feed alley	For feed cart	4′-0″
Driveway	For wagon, spreader, or truck	9′-0″
Doors and gate	Drive-through	9′-0″
Doors and gate	To small pens	4′-0″

STORAGE SPACE REQUIREMENTS FOR FEED AND BEDDING

The space requirements for feed storage for the livestock enterprise—whether it be for cattle, hogs, sheep, or horses, or as is more frequently the case, a combination of these—vary so widely that it is difficult to provide a suggested method of calculating space requirements applicable to such diverse conditions. The amount of feed to be stored depends primarily upon: (1) length of pasture season, (2) method of feeding and management, (3) kind of feed, (4) climate, and (5) the proportion of feeds produced on the farm or ranch in comparison with those purchased. Normally, the storage capacity should be sufficient to handle all feed grain and silage grown on the farm and to hold purchased supplies. Forage and bedding may or may not be stored under cover. In those areas where weather conditions permit, hay and straw are frequently stacked in the fields or near the barns in loose, baled, or chopped form. Sometimes, poled framed sheds or a cheap cover of waterproof paper or wild grass is used for protection. Other forms of low-cost storage include temporary upright silos, trench silos, and temporary grain bins.

Table 10 gives the storage space requirements for feed and bedding. This information may be helpful to the individual operator who desires to compute the barn space required for a specific livestock enterprise. This table also provides a convenient means of estimating the amount of feed or bedding in storage.

To compute the tons of loose hay in a deep mow, multiply the length by the width by the height (all in feet) and divide

by a figure between 340 and 500 (the exact figure depends upon the height and looseness). To find the number of bushels of shelled corn in a bin, multiply the length by the width by the depth (all in feet) and divide by 1.25.

TABLE 10

STORAGE SPACE REQUIREMENTS FOR FEED AND BEDDING

Kind of feed or bedding	Pounds per cubic feet	Cubic feet per ton (approx.)	Pounds per bushel of grain	Cubic feet per bushel
Roughage and bedding:				
Hay—loose in shallow mows	4-5	500-400		
Hay—loose in deep mows	4-6	500-340		
Hay—baled medium to loose	15+	133		
Hay—baled tight	20	100		
Hay—chopped long cut	8	250		
Hay—chopped short cut	12	167		
Straw—baled	12	167		
Shavings—baled	20	100		
Silage—shallow upright or trench silos	30	67		
Silage—high silos	50	40		
Mill feed:				
Bran	13	154		
Middlings	25	80		
Linseed or soybean meal	35			
Grain:				
Corn—shelled	45	45	56	1.25
Corn—ear	28	72	70	2.50
Corn—snapped	25	81	80	3.25
Oats	26	77	32	1.25
Barley	39	51	48	1.25
Wheat	48	42	60	1.25
Rye	45	44	56	1.25
Grain sorghum	45	44	56	1.25

PAVED LOTS AND FEEDING FLOORS

In those areas in which barnyard mud is a usual winter problem, a concrete lot or feeding floor for cattle, hogs, and sheep may constitute one of the most profitable improvements. A properly constructed paved feed lot results in: (1) a saving in time and labor; (2) less waste in feed and bedding, especially when hogs follow cattle; (3) greater conservation of manure; (4) greater sanitation and fewer diseases; and (5) more animal

comfort, which means greater gains and production. Corn Belt cattle feeders generally figure that paving for a six-months' period of winter and spring feeding pays for itself at the rate of $5.00 per steer. This is the saving computed on the cattle and hogs running with them and does not include the greater recovery of manure.

The paved feed lot should be located where it will make for convenience in feeding and watering operations and will be shel-



Fig. 65. A paved corral lot used for fattening steers on the Frandsen Farm, Story City, Iowa. Note that the cattle are clean and free from mud and manure. (Courtesy, Dale Woolsoncroft, Iowa State College, and the Portland Cement Association.)

tered from the prevailing winds and exposed to the sun. In most areas, these conditions are met by locating the paved lot adjacent to the building housing the animals and on the south or east side thereof.

Concrete feeding floors for hogs should be about 4 inches thick; for cattle, 5 inches. Subsurface drainage can be assured and proper footing obtained by placing the concrete slab on a well-tamped fill consisting of 3 to 6 inches of fine stone, gravel, or cinders. Adequate surface drainage may be provided by sloping the floor about $\frac{1}{4}$ inch per foot. In order to provide for expansion and contraction, the floor should be formed in sections about 10 feet square. An apron or cutoff wall should be added

to prevent undermining of the floor. A low curb around the edge of the paving will also hold the manure; but some openings should be left to let rain water escape. The floor should be finished with a wood float or broom, leaving an even, yet gritty, nonslip surface. The size of the paved lot will depend upon the class and number of animals kept and on management practices. Some stockmen also prefer to have a part of the lot unpaved to permit the animals to loiter on bare ground during dry weather. The latter point is of special importance with purebred breeders; for it is recognized that a long stay on a hard-surfaced floor may make for crooked legs on young animals.

Hard-surfaced lots may be constructed with crushed limestone, gravel, paving brick, concrete, or a mixture of calcium chloride and road oil. The latter preparation is still in the experimental stage, and it is too early to evaluate it. Although concrete is the most costly, it is also the most permanent and satisfactory —all factors considered.

Properly constructed paved lots or floors are easy to clean, and the manure is not trampled into the mud. It may be scooped up with a shovel or manure loader. On large floors, cleaning is facilitated by first bunching the refuse with a tractor equipped with a blade.

TYPES OF FLOORS FOR STALLS OR STABLES

Floors for animals may be and are constructed of numerous materials—including clay, clay with a concrete border, plank, concrete, concrete with board surfacing, cork brick, creosoted wooden blocks, cinders, or various combinations of these materials. Regardless of the type of flooring material, for a good dry bed there should be a combination of surface and subsurface drainage together with a cover provided by a suitable absorbent litter.

Most stockmen feel that a perfect flooring material has not yet been developed, as each of the existing types has certain disadvantages. Rough wooden floors furnish good traction for animals and are warm to lie upon; but they are absorbent and unsanitary. They also lack durability and often harbor rats and other rodents. Concrete floors are durable, impervious, easily drained, and sanitary; but they are rigid and without resilient qualities, are slippery when wet, and are cold to lie upon. Clay floors are noiseless, springy; and they afford a firm natural footing unless wet, but they are difficult to keep clean and level. After considering both the advantages and disadvantages of the

many types of flooring materials, most practical stockmen are agreed that concrete, under average conditions, is the most satisfactory flooring for central hog houses and that clay is the most satisfactory flooring for cattle, sheep, and horse barns or shelters.

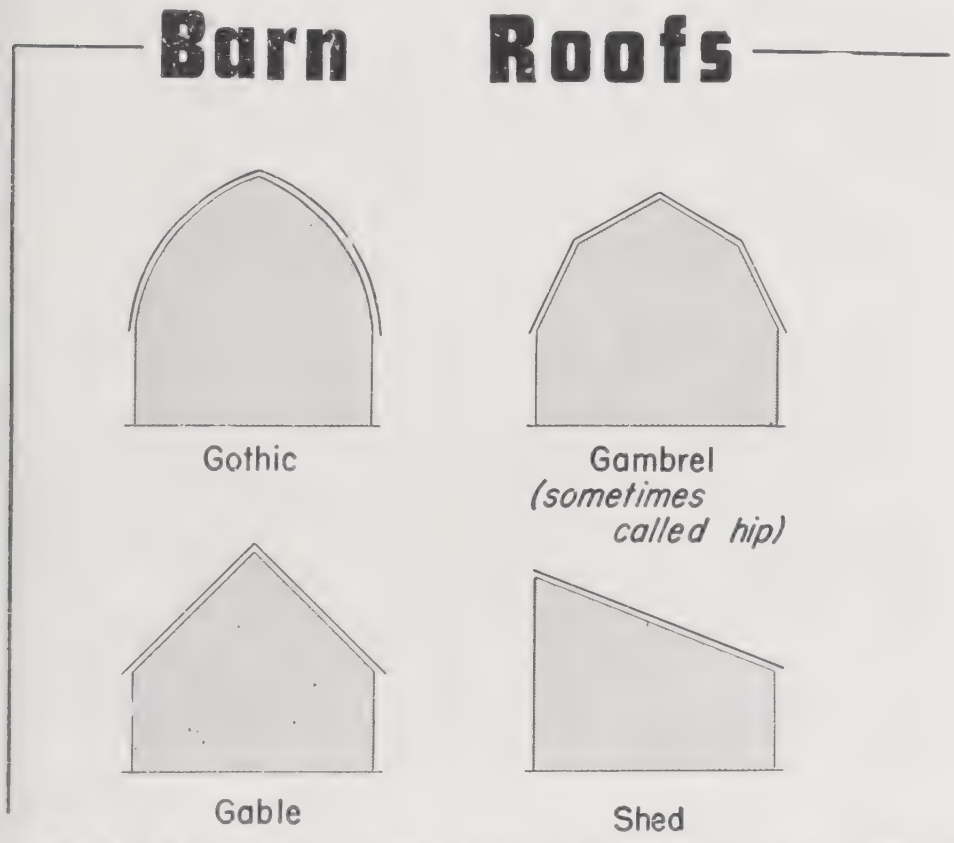


Fig. 66. Types of barn roofs. The shape, style, slope, and type of roof construction selected should be based upon the function to be served, the economy of construction, strength, and appearance. (Drawing by R. F. Johnson.)

TYPES OF BARN ROOFS

Figure 66 illustrates various roof shapes. The shape, style, slope, and type of roof construction selected should be based upon the function to be served, the economy of construction, strength, and appearance.

On permanent buildings, the roofing should last fifteen to twenty years without replacement. Among the more durable roofings are: cedar shingles; cement-asbestos shingles; 250-pound asphalt shingles; 28-gauge 2-ounce coated steel sheets; and aluminum.

SCALES

Scales are a valuable piece of equipment for the modern stock farm or ranch; for they make it possible to determine weights of animals on record-of-performance studies, to secure the accurate rate of gains of fattening animals, to sell animals on the farm or ranch on a weight basis, and to buy and sell feed on a weight basis. For greatest usefulness, scales should be so arranged that a pen may be set up quickly when weighing mature animals or may be removed when weighing feed.

A convenient place for the farm scales is in the farm court, next to the corrals or feed lot. In this location, the scale is convenient for weighing livestock or loads of feed and supplies.



Fig. 67. Livestock scales connected with corrals and loading chute. Scales are a valuable piece of equipment for the modern farm or ranch. (Photo by M. E. Ensminger.)

THE MANURE PIT

Farm manure is valuable chiefly for its organic matter and for the three nutrients—nitrogen, phosphorus, and potassium—that it contains. Much of these valuable fertilizing elements is lost, however, if the manure is piled in an unpaved yard exposed to sun, wind, and rain. Under such conditions, the loss of nitrogen by fermentation and the loss of phosphorus and potassium by leaching usually destroys more than half the original fertilizing value of the manure.

Two management practices will save most of the nitrogen and practically all of the phosphorus and potassium in manure. These are (1) the generous use of bedding (deep litter) to take up the liquids containing the larger portion of the fertilizing elements and (2) the storage of manure in damp, well-compacted

piles in a watertight, weather-protected concrete pit. These two practices will double the fertilizing value of farm manure. A manure pit is desirable, for generally it is impossible and impractical to remove the manure to the fields each day. Therefore, some receptacle must be provided in which the manure may be placed until hauled out. The amount of manure produced by animals during a period of a year will vary according to the size of



Fig. 68. A concrete manure pit on an Iowa farm.
(Courtesy, Portland Cement Association.)

the animal, and the kind and amount of bedding. On the average, however, farm animals will produce about the following tonnage of manure in one year: dairy cow, 8.5; beef cattle, 4.0; horse, 5.2; sheep, 0.4; and hog, 0.6.

THE SILO

The first U. S. silo built by white man is said to have been erected by F. Morris in Maryland in 1876. But Columbus found that the Indians used pits or trenches in which to store their grain, and centuries earlier in the Old World silos were used as a means of preserving both grain and green forage.

The value and use of silage in feeding the respective classes of livestock are fully covered in the chapters on feeding. The ensuing discussion will be devoted to a discussion of types, requisites, and capacities of silos—especially from structural and utility standpoints.

Types of Silos

Silos are of four types: (1) above-ground permanent silos, (2) above-ground temporary silos, (3) below-ground permanent silos, and (4) below-ground temporary silos.



Fig. 69. Above-ground permanent silos. Permanent silos of this type may be constructed of concrete, brick, tile, metal, wood, and other materials. (Courtesy, Portland Cement Association.)

Above-ground permanent silos may be constructed of concrete, brick, tile, metal, wood, or other materials. The choice of the material will depend on local conditions. The requisites of permanent upright silos are: (1) airtight walls; (2) cylindrical shape; (3) smooth, strong walls of durable material; (4) proper diameter; and (5) adequate depth. Although upright silos are usually quite handy and very durable, they are the most expensive of all types.

Above-ground temporary silos are usually enclosed by a slat or picket-type of fencing, such as is used for snow fences; and they are lined with a tough reinforced paper made especially for the purpose. Stake silos with little or no exterior protection are also used in some cases. Generally, temporary silos of these types are used to meet emergencies and to supplement permanent silos. They are low in cost, can be erected on short notice, require

no special foundation, and can be set up on almost any site convenient for filling and feeding. These silos are not so well adapted to ensiling grasses or legumes, because there is likely to be heavy spoilage during the summer months. If properly constructed, however, they are very satisfactory for corn or sorghum silage.

Below-ground silos are of two types: the pit silo and the trench silo. The pit silo, which is similar to a dug well or cistern, is circular in form and may be dug as deep as desired or as deep as the ground-water level will permit. In comparison with above-ground silos, pit silos have the following advantages: (1) They are never damaged by storm or fire, (2) they require less reinforcing, (3) they minimize spoilage losses because of not having doors, and (4) they avoid frozen silage. Pit silos are dangerous, however, due to the frequent presence of suffocating carbon dioxide gas.



Fig. 70. A trench silo at Dixon Springs, Illinois. Note the concrete walls to prevent the sides from caving in and to save silage from spoilage. Below-ground silos (pit and trench silos) are especially popular in semi-arid regions. They are not subject to storm or fire damage. Also, with a trench silo a power loader can be used conveniently to reduce feeding time. (Courtesy, Portland Cement Association.)

The trench silo is a trench-like structure that can be built quickly and at low cost. It has the advantages of: (1) low initial cost, (2) low cost for filling machinery, (3) relative freedom from freezing, and (4) ease of construction. The chief disadvantage of the trench silo in comparison with an upright type is the larger area to seal to prevent spoilage. Because of the shallowness of this type, the forage must be packed very thoroughly in a trench silo by driving a tractor or team of horses back and forth over it. When filling is completed, the top must be care-

fully sealed by (1) dirt, (2) wet straw or poor-quality hay or marsh grass, (3) a mixture of dirt and straw, or (4) waterproof paper covered with dirt or straw.

Below-ground silos (pit and trench silos), most generally used in the semi-arid regions, are considered permanent when walled up with some durable material such as concrete. They are considered temporary when the wall consists of dirt, boards, or some material lacking in durability.

Size of Silo

The size of silo to build should be determined by needs. With upright or pit silos, this means (1) that the diameter should be determined by quantity of silage to be fed daily, and (2) that the height (depth in a pit silo) should be determined by the length of the silage feeding period. Similar consideration should be accorded with trench silos.

If the diameter is too great, the silage will be exposed too long before it is fed; and unless a quantity is thrown away each day, spoiled silage will be fed.

The minimum recommended rate of removal of silage varies with the temperature. In most sections of the United States, it is desirable that a minimum of 1½ inches of silage be removed from upright silos daily during the winter feeding period, with the quantity increased to a minimum of 3 inches when summer feeding is practiced. Of course, the total daily silage consumption on any given farm or ranch will be determined by (1) the class and size of animals, (2) the number of animals, and (3) the rate of silage feeding. Some suggestions on how much silage to feed cattle, sheep, and horses are found in the Handy Feeding Guides in the respective feeding chapters.

Silo height should be determined primarily by the length of the intended feeding period. In general, however, the height should not be less than twice, nor more than three and one-half times, the diameter. The greater the depth the better the quality of silage and the greater the unit capacity. Extreme height is to be avoided because of the excessive power required to elevate the cut silage material. Also, it is noteworthy that, with silos of the larger diameters, more labor is required in carrying the silage to the silo door for removal.

Instructions for calculating the correct diameter and height of an upright (or pit) silo, and the proper dimensions of a trench silo, are presented in the Appendix.

Carbon Dioxide Danger in Silos

After an intermission in filling or for a few days after filling the upright silo, special care must be exercised in entering the silo during the fermenting stage; for suffocating carbon dioxide gas, which is heavier than air, may accumulate near the surface of the silage. This may leave insufficient oxygen for human life. *Pit silos are always dangerous,* even long after the filling operations. Because of this, it is recommended that a simple test for carbon dioxide gas be made before entering a newly filled upright silo or any pit silo, regardless of how long it has been filled. If a lighted lantern or candle lowered to the level of the silage goes out, it is not safe to enter. The gas may be let out of an upright silo by removing a silo door at the level of the silage.

If no lantern or candle is available for testing purposes, agitate the air and drive out the carbon dioxide before entering the silo. This may be done by (1) operating the blower for a few minutes if it is still connected or by (2) swinging a blanket, a piece of canvas, a tree branch, or a burlap bag vigorously.

The hazard from suffocating gas is especially great in pit-type silos. Although above-ground silos are not free from gas danger, large quantities of gas seldom accumulate unless the doors are put in too far above the silage level.

A victim of silo gas should be moved into fresh air as soon as possible, and artificial respiration should be applied. A physician should be called immediately.

References

Further information relative to specially designed and adapted buildings and equipment for each of the respective classes of livestock is presented in the following books by the same author and the same publisher as *Animal Science:*

Beef Cattle Husbandry

Sheep Husbandry

Swine Husbandry

Horse Husbandry

CHAPTER V

ANIMAL HEALTH, DISEASE PREVENTION, AND PARASITE CONTROL[1]

In the natural state, animals roved over the broad prairies or through the virgin forests, gleaning the feeds provided by nature and bedding down on new sites each night. Finally, as civilization advanced and herds and flocks increased in size, animals were placed in restricted areas. Simultaneously, they were bred and fed for greater production of meat, milk, eggs, fiber, or for power and speed. Under unnatural conditions of close confinement, greater numbers, forced production, and eating and sleeping in close contact with their own body discharges, the control of diseases and parasites became of paramount importance.

Each year, many American farmers and ranchers, from one end of the country to the other, are robbed of their profits in livestock production—robbed by diseases and parasites. Death losses take a tremendous toll, but even greater economic losses result from the decreased growth, gains, or production among the living—from the increased production costs of meat, milk, eggs, wool, and power. It has been conservatively estimated that the annual United States losses from the more important diseases, parasites, and pests of livestock and poultry aggregate from one-half to one billion dollars or more. But there is a solution to this dilemma. A program of strict livestock sanitation, disease prevention, and parasite control is the answer.

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It is to be emphasized, however, that the review accorded by these eminent authorities does not constitute either full approval or full agreement of the reviewers and the authors on the contents of these chapters.

It is hoped that the information presented in this chapter will be of special value in assisting the stockman in the prevention of diseases and parasites. Although final diagnosis of disease and prescribed treatment should be left in the hands of a competent veterinarian, a well enlightened producer will: (1) be in a better position to institute a program designed to assure herd health, (2) more readily recognize any serious outbreak of disease and promptly call a veterinarian, (3) prevent unnecessary suffering of sick animals, (4) be better qualified to assist the veterinarian in administering treatment, and (5) be more competent in carrying out a program designed to bring the disease under control with a minimum spread of the infection.

ANIMAL DISEASE

In general, *disease is defined as any departure from the state of health*. Beyond a doubt, the most serious menace threatening the livestock industry is animal ill-health. There are many degrees of ill-health, but by far the largest loss is a result of the diseases that are due to a common factor transmitted from animal to animal. These disorders are classed as infectious, contagious, and parasitic diseases and are considered theoretically controllable. Today, with the modern rapid transportation facilities and the dense livestock population centers, the opportunity for animals to become infected are greatly increased compared with a generation ago.

Few people realize the extent of losses caused by diseases, parasites, and insect pests. One is inclined to consider only those costs caused by death or depreciation, but actual animal losses are far more extensive. Some cost also is chargeable to the prevention of diseases that do not exist within the United States—for example, it is estimated that in the four-year period, 1946-1950, the U. S. spent $120,000,000 in the cooperative foot-and-mouth disease eradication program in Mexico.

The fact that many animal diseases are transmissible to man is well known, and, as a result, the ever-present human danger adds to the economic loss. Thus, one eminent health official has estimated that human beings are susceptible to at least 80 diseases of animals. Of most concern in this respect are such animal diseases as actinomycosis, anthrax, Q fever, rabies, trichinosis, tuberculosis, and tularemia. Rigid meat and milk inspection is necessary for the protection of human health.

Quarantines within the country may cause depreciation of land values or may even restrict whole agricultural programs. Shipping injuries alone present a formidable economic loss. Although it is difficult to estimate the actual death loss due to parasites, it is even more difficult to make a proper appraisal of the losses due to unthriftiness and stunting that invariably result from parasitic invasions.

Despite all of these disturbing factors, it is satisfying to know that the United States is regarded as the safest country in the world for a flourishing livestock industry. In order to insure further progress, however, thousands of workers—including scientists with the U. S. Department of Agriculture, colleges, pharmaceutical houses, practicing veterinarians, and others—are constantly striving to make this country even healthier for both man and beast.

Causes of Disease

Any agent that may bring about an abnormal condition of any or all tissues of the body is a disease-producing entity. Among the chief causes may be listed infectious agents such as bacteria, viruses, and parasites and noninfectious agents, including chemicals, poisons of various types, faulty nutrition, and injuries. In addition to the actual causative agents, any of the following conditions may predispose disease: overwork, exposure to cold, and long shipments—especially in cold weather. The present discussion will be limited to bacteria, viruses, and parasites—the other causative agents being covered elsewhere; for example, both nutritional diseases and poisonous plants are included in the chapter devoted to feeding livestock.

The activity of disease in the animal body results in a change in the tissues invaded. It is usually marked by inflammation, which is manifested by increased blood supply to the part affected and by heat, redness, swelling, and pain in the affected part.

Diseases are often named after the part affected with the suffix "itis" (meaning inflammation) attached—for example, conjuctivitis (inflammation of the conjunctiva of the eye) or enteritis (inflammation of the intestines, or "entrails").

The infection of a tissue and production of a disease by a living agent is not always easily accomplished. The agent must first gain entrance to the animal by one of the body openings (respiratory, digestive, or genital tract) or through the skin. It then usually multiplies and attacks the tissues. To accomplish this, it must be sufficiently powerful (virulent) to overcome the

defenses of the animal body. The defenses of the animal body vary and may be weak or entirely lacking, especially under conditions of a low nutritional plane and poor management practices.

BACTERIA:

Bacteria are defined as minute one-celled organisms of varying sizes and shapes which multiply by transverse fission and possess no chlorophyll. They are exceedingly numerous in nature, and the majority are beneficial—for example, those that create the fermentation processes used in the manufacture of vinegar and the ripening of cheese. The few that cause disease are referred to as pathogens.

Bacteria are all classified by various distinguishing features. Some bacteria will grow only on special types of media in varying amounts of oxygen. Some are motile, whereas others lack the power of locomotion. Then there are those bacteria that under certain conditions form spores that are highly resistant to destruction and may live for years. Some also possess the ability to elaborate toxic products within themselves or in the media in which they grow—as does, for example, the fatal and relatively common toxin which causes botulism poisoning.

VIRUSES:

Viruses are defined as ultramicroscopic agents (objects that cannot be seen through ordinary microscopes). Usually they are filtrable, and they are unable to propagate themselves in the absence of living cells. They are frequently the cause of disease in animals. They are not all considered to be living entities.

There is still much to be learned about viruses; although recently what has been thought to be virus particles have been photographed, and much progress is being made in the store of knowledge relative to them. Many viruses have been propagated, thus facilitating their study and the development of immunization methods.

Viruses are generally classified according to the tissues they invade, although this is a very arbitrary method, as some viruses invade many tissues. Virus diseases are often complicated by the presence of secondary bacterial invaders. In some cases, a virus is unable to produce a disease in the absence of so-called secondary bacteria (for example, as in swine influenza).

PARASITES:

Broadly speaking, parasites are organisms living in, on, or at the expense of another living organism. They include fungi,

protozoa (or unicellular animals), arthropods (or insects, ticks, and related forms), and helminths (or worms). Bacteria come under this definition but are being eliminated here since they already have been discussed. Any animal that serves as a residence for a parasite is referred to as a host.

In order to complete their life span (cycle), some parasites require only one host while others need more.

While in residence, the parasite usually seriously affects the host, but there are notable exceptions. Some of the ways in which the parasite may do harm are: (1) by food absorption, (2) sucking blood or lymph, (3) feeding on the tissue of the host, (4) obstructing passages, (5) by causing nodules or growths, (6) by irritation, (7) by transmission of diseases. These may result in death of the affected animal; or they may cause large financial loss through stunted growth, lowered production, general unthriftiness, and emaciation.

Although thousands of parasites affect human beings and animals, only a few will be discussed.

PROTOZOA

Protozoa (or unicellular animals) are the simplest form of animal life; they consist of only a single cell. There are many classifications of protozoa depending upon method of reproduction and locomotion and general shape and structure. Since most of them are free-living (occurring in the soil, water, etc.), only a few concern human and animal health. Malaria and amoebic dysentery are examples of devastating human parasitic diseases caused by micro-organisms known as protozoa; whereas among the protozoan diseases of animals are coccidiosis and anaplasmosis.

HELMINTHS (OR WORM PARASITES)

Helminths (or worm parasites) are many-celled animals varying greatly in size, shape, structure, and physiology. With few exceptions, the eggs or larvae must leave the host animal in which they originate to undergo further development on the ground, elsewhere in the open, or in intermediate hosts. For purposes of description they are classified here as (1) flukes (or trematodes), (2) tapeworms (or cestodes), (3) roundworms (or nematodes), and (4) thorny-headed worms (or acanthocephala).

FLUKES

The flukes (or trematodes) are soft, flat, leaf-shaped parasitic worms. With few exceptions, they are hermaphroditic (the

generative organs combine those of both sexes), and they usually have two or more hosts, one of which always includes a mollusk (snail). The only flukes of known livestock importance in this country are the liver flukes that commonly parasitize cattle; wild ruminants; sheep and goats; and less frequently, swine. Liver flukes rarely, if ever, infect horses.

TAPEWORMS

Without exception tapeworms are parasitic. They range in size from a fraction of an inch to over ten yards in length. They occur as adult worms in the intestines and as larvae or bladder worms in various locations outside the alimentary canal—including the muscles, abdominal cavity, liver, lungs, brain, eye, and other organs and tissues. Although there appears to be little resemblance between an adult tapeworm and a bladder worm, the latter is really only the larval stage of the former.

Because bladder worms live in the tissue of animals, they cause more damage than the adult worm that resides mainly in the digestive tract. For example, the disease of sheep known as gid is caused by the presence in the brain of a bladder worm an inch or so in diameter. The pork tapeworm sometimes affects the brain and eye of man.

The adult worms injure the lining of the digestive tract and probably rob food from the host animal.

ROUNDWORMS

Roundworms, or nematodes, are unsegmented worms, usually cylindrical and elongate in shape and with tapered ends. They may be free-living or parasitic, and they vary greatly in size. Some are barely visible to the naked eye; others are a foot in length and as thick as an ordinary lead pencil.

The forms of infection by nematodes vary a great deal. The worms enter a variety of locations outside of the intestinal tract and wander, apparently aimlessly, in various organs and cavities, sometimes dying there.

Roundworms are among the most important parasites of man and animals. They suck blood, carry disease, excrete toxins, disturb digestion and respiration, and generally cause emaciation. Hookworms, trichinella, strongyles, nodular worms, and stomach worms of cattle, sheep, and goats are a few examples.

THORNY-HEADED WORMS

The thorny-headed worms (or acanthocephala) derive their name from the peculiar anatomical structure characteristic of

these worms—a retractible snout armed with hooks. The sexes are separate. Only one species, the thorny-headed worm of swine, is of importance to the livestock industry.

ANTHROPODS (INSECTS, TICKS, ETC.)

Some parasites are transmitted from one host animal to another directly, without the intervention of intermediate hosts, whereas the propagation and spread of others necessitates the presence of an intermediate host or hosts. Those hosts that transmit parasites are known as vectors or carriers. Knowledge of the intermediate hosts and vectors is extremely important in control programs. Thus, without mosquitoes, there would be no malaria; and without ticks, there would be no tick or Texas fever. Other intermediate hosts and vectors include flies, beetles, snails, and slugs. In fact, almost any animal, and even human beings, may serve as an intermediate host for parasites.

ANIMAL HEALTH

Keeping livestock healthy and sound not only entails the reduction of death losses of animals generally but also includes reduction of losses from unthriftiness. In addition to being economically important in profitable and successful livestock production, animal health is important in the maintenance and protection of human health.

Although modern science has conceived many artificial protective mechanisms against disease, there is no substitute for livestock sanitation and disease prevention. The artificial achievements, valuable as they are, are merely an adjunct to a high state of natural health that is built around a program of improved breeding, feeding, and management.

Immunity

The animal body is remarkably equipped to fight disease. Chief among this equipment are large white blood cells, called phagocytes, which are able to overcome many invading organisms.

The body also has the ability, when properly stimulated by a given organism or toxin, to produce antibodies and/or antitoxins. When an animal has enough antibodies for overcoming particular (disease-producing) organisms, it is said to be immune to that disease. Immunity denotes complete resistance to disease, but the term is used in a relative sense.

When immunity to a disease is inherited, it is referred to as a natural immunity. For example, when sheep are exposed to hog cholera they never contract the disease because they have a type

of natural immunity referred to as species immunity. Algerian sheep are said to be highly resistant to anthrax, and this constitutes a type of natural immunity called racial immunity.

Acquired immunity or resistance is either active or passive. When the animal is stimulated in such manner as to cause it to produce antibodies, it is said to have acquired active immunity. On the other hand, if an animal is injected with the antibodies (or immune bodies) produced by an actively immunized animal, it is referred to as an acquired passive immunity. Such immunity is usually conferred by the injection of blood serum from immunized animals, the serum carrying with it the substances by which the protection is conferred. Passive immunization confers immunity upon its injection, but the immunity disappears within three to six weeks.

In active immunity, however, resistance is not developed until after one or two weeks; but it is far more lasting, for the animal apparently keeps on manufacturing antibodies. It can be said, therefore, that active immunity has a great advantage. There are exceptions, however—for example, when a disease must be checked immediately as in a virulent outbreak of swine erysipelas, when immune serum from actively immunized horses is injected.

It is noteworthy that young suckling mammals secure a passive immunity from the colostrum that they obtain from the mother for the first few days following birth.

Vaccination

Vaccination is generally defined as the process of inoculating an animal with virus or other material for preventing disease by producing active immunity.

In regions where a disease appears season after season, it is advised that healthy susceptible animals be vaccinated before being exposed and before there is a disease outbreak. This practice is recommended not only because it takes time to produce an active immunity but also because some animals may be about to be infected with the disease. The delay of vaccination until there is a disease outbreak may increase the seriousness of the infection. In addition, a new outbreak will "reseed" the premises with the infective agent.

In vaccination, the object, as has been previously pointed out, is to produce in the animal a reaction that in some cases is a mild form of the disease.



Fig. 71. Vaccinating a calf. Vaccination is generally defined as the process of inoculating an animal with virus or other material for preventing disease by producing active immunity. (Courtesy, Pitman-Moore Company.)



Fig. 72. Vaccinating a pig. In vaccination, the object is to produce in the animal a reaction that in some cases is a mild form of the disease. (Courtesy, Pitman-Moore Company.)

It is a mistake, however, to depend on vaccination alone for disease prevention, and one should always insure its success by the removal of all interfering adverse conditions. It must also be said that varying degrees of immunity or resistance result when animals are actively immunized. Individual animals vary widely in their response to similar vaccinations. Heredity also plays a part in the determination of the level of resistance. In addition, nutritional and management practices play an important part in degrees of resistance displayed by animals.

Biologics

Biologics may be defined as medicinal preparations made from micro-organisms (bacteria, protozoa, or viruses) and their products. They include various vaccines, bacterins, serums, and similar preparations. These agents are one of the most valuable contributions to animal health, and they are constantly being improved. They are used essentially for rendering animals immune to various infections.

It must be noted, however, that not all attempts to confer immunity by biologics are successful. In some cases, it seems impossible to create any immunity against some infections. The common cold is a case in point. In other cases, the animal may die from the disease or its complications, in spite of an inoculation because of a biologic of poor quality, infection before the treatment is begun or improper administration of the biologic.

VACCINES:

Usually vaccines are defined as suspensions of live microorganisms (bacteria or virus) or microorganisms that have had their vitality reduced by one of a large number of ways (heat, drying, chemical, animal transmission). As pointed out previously, vaccines are purposely administered to produce a mild attack of disease, thus stimulating the resistance of that animal to that specific disease. They are employed mainly in the prevention rather than in curing of disease. Examples are strain 19 vaccine of *Brucella abortus*, anthrax vaccine and hog cholera vaccine. Great care must be used in their preparation, storage, and administration. It must be pointed out that improper use of vaccines may result in disease outbreaks. It is strongly advised, therefore, that a veterinarian be consulted about their use.

BACTERINS:

Bacterins are standardized suspensions of bacteria (and their products) that have been killed and are unable to produce disease.

Theoretically, bacterins should be useful in the prevention of every infectious disease in which the causative agent is known. Unfortunately, they do not always give the desired results, especially in diseases of a chronic nature.

Often a product may be a mixed bacterin; that is, it may contain more than one organism. This usually includes secondary invaders when the true causative agent is unknown.

SERUMS:

Serums, also known as immune blood serum or immune serum, are obtained from the blood of animals (often horses) that have developed a solid immunity from having received one or more doses of infectious organisms. They are used for the protective nature of the antibodies that they contain, which stop the action of an infectious agent or neutralize a produce of that agent.

TOXOIDS (OR ANATOXINS):

Toxoids (anatoxins)—consisting of detoxified, disease-producing toxins—are gaining in importance and are used very extensively for immunization purposes; examples include diphtheria toxoid and tetanus toxoid.

OTHER ARTIFICIAL PROTECTIVE MECHANISMS AGAINST DISEASE:

In addition to the vaccines, bacterins, serums and toxoids, the following products are employed for the protection of animals against disease: sensitized vaccines, sensitized bacterins, germ-free extracts, natural and artificial aggressins, and bacterial filtrates. Although these products are prepared differently, they all serve to provide protective substances against corresponding infections.

DIAGNOSTIC AGENTS:

Other biological products are used solely for the diagnosis of diseases. Tuberculin is an example of such an agent, and it is considered accurate enough to cause the slaughter of an apparently normal animal that reacts positively. Another agent now employed for diagnosis is an antigen which is made up of Brucella organisms and is employed in the detection of brucellosis disease reactors. Use is made here of the fact that when an animal is infected with Brucella organisms it produces an antibody called agglutinin. When serum from a positive animal is brought in contact with the specific antigen, a characteristic agglutination or clumping occurs.

Drugs

Drugs, or medicinal agents, are substances of mineral, vegetable, or animal origin used in the relief of pain or for the cure of disease. Much superstition cloaks the reasons for the recommended use of many drugs that have been employed for centuries. An example of this is liver wort, which was heralded as a sure cure for liver disorders only because it was shaped like a liver. Unfortunately, there is no known cure-all for a large number of diseases or for the relief of a great number of different parasitisms.

Lacking the knowledge of limitations of drugs and the nature of disease, many farmers and ranchers have been sold worthless products. At the present time, there is a flourishing business in flooding the market with various "cure-alls" that are sold under such names as "tonic," "reconditioner," "worm expeller," "liver medicine," "mineral mixture," "mineral and vitamin mix," "regulator," and numerous others. It is a very poor practice to disregard the advice of reputable veterinarians and experimental workers and rely on claims made by unscrupulous manufacturers of preparations of questionable or fraudulent nature. Most of these patent drugs are sold for fantastic prices, considering their actual cost, and most of their ingredients are never indicated. To avoid being swindled, purchases should be limited to preparations of reliable firms and then confined to those recommended by the local veterinarian. Fortunately, the Food and Drug Administration has been very vigilant and has been instrumental in the disappearance of many misbranded drugs and remedies from interstate channels.

General Animal Sanitation and Disease Prevention

In order to reduce the possibility of disease, one must adopt certain management practices relative to the environment of the animal. It has been said that domestication and increased animal numbers imply sort of a contract. Man, in fulfilling his obligation for services rendered, must protect his animals from the elements, parasites, and diseases and furnish them sanitary quarters and suitable rations. Abuse leads to the reduction of profit—a case in which money and decency are on the same side of the ledger.

Animals require sanitary quarters. In the wild state, they had access to plenty of fresh air, clean feed, and plenty of room. They are naturally of clean habits and if given the choice will not voluntarily consume contaminated feed nor lie in filth.

VENTILATION:

The need for ventilation is not as great for the animal as it is for human beings, for most of the animal's life is spent out of doors where plenty of fresh air is available. Ventilation is significant only when animals are housed in crowded quarters.

Ventilation is the act of causing the movement of air through buildings with the objective of supplanting foul air with fresh air containing needed oxygen. Contrary to common opinion, when a feeling of discomfort is noticed, it is the result of oxygen starvation rather than carbon dioxide poisoning.

The amount of moisture in the air is important. When improper ventilation prevents proper evaporation, the moisture content of the air increases. If humidity rises too high, interfering with heat elimination, heat stroke may ensue. Moist air generally is a more favorable medium for the existence of micro-organisms, thus lending itself well to the transmission of contagious diseases. When one animal is infected with a contagious disease and is closely housed with others, an epidemic will usually follow. The air may also pick up various noxious gases, such as ammonia from decomposing urine. This may cause irritation to the sensitive membranes of the mouth, eyes, nose, and respiratory tract.

It is difficult to set a figure for the amount of air space to be allotted each animal. A rule of thumb calls for about 60 cubic feet of air space per 100 pounds body weight, but sheep should be allowed one-half more. One should guard against direct drafts and properly insulate against extreme cold.

HOUSING:

Although housing and close confinement predispose animals to more disease, it is often very necessary. Housing must frequently be provided to facilitate handling, to combat the elements, or to furnish protection during illness or when young are arriving. Proper drainage and dryness, adequate space, and good lighting are some of the requirements for good housing. In addition, animal quarters must be of such construction as to facilitate proper cleaning, disinfection and maintenance of sanitary conditions. This includes suitable floors, adequate waste disposal, and proper absorbent bedding. Further discussion of the requisites of livestock buildings is found in Chapter IV.

ADEQUATE MANURE DISPOSAL:

Situations that compel animals to live in close contact with their own body excreta are one of the most injurious to physical

well-being. Urine, feces, exhalations, and nose and mouth discharges may often contain disease-producing agents and furnish an ideal medium for the growth of micro-organisms. Stockmen are fully aware of the miraculous recovery many animals undergo when taken from small, unsanitary enclosures to good, clean pastures.

The importance of frequently removing excrement from the immediate surroundings (enclosures, barns, and loafing sheds) cannot be stressed too much. The method of disposal of solid and liquid manure is also very important. As this manure may contain a variety of various parasites and eggs, proper disposal offers an excellent opportunity for breaking the life cycles of these parasites. On the other hand, if left in an accessible place for animals, manure can be a rich never-ending source of disease and parasitism.

In order to insure the killing of many harmful parasites, one may store manure (for two weeks to a month) so that the heat generated will cause their death. It should be stored in a covered concrete pit and located far enough away from the buildings to prevent contamination. These enclosures should be inaccessible to all animals. Spraying manure pits with DDT makes it possible to inhibit fly development. If the manure is believed to be free of specific infectious micro-organisms (for example, tuberculosis, brucellosis, and blackleg), it may be spread daily on arable land containing no animals. Here the purifying elements—such as rain, sunshine, soil and vegetable processes—will tend to render the manure sanitary. Food and water should always be protected from contamination by manure.

PASTURE ROTATION:

Pasture rotation provides a very practical method of control of many diseases and parasites. Permanent pastures used by one species of animal are to be regarded as highly dangerous for profitable endeavors. A method by which land areas for pasturage are systematically changed periodically to crop production is to be recommended.

As many parasites (including bacteria) are often specific for a certain host (for example, bots of horses affect no other animal), pastures may be rotated between different species.

CARCASS DISPOSAL:

In the disposal of carcasses, it is a safe rule to assume that all are a source of some infection and to subsequently adopt the proper sanitary precautions.

The most sanitary method of destroying a carcass is to burn it, preferably at the site of death in order to prevent the contamination of surrounding ground. A trench of sufficient size should be prepared, a fire built, and the animal placed on top so that it will be consumed in its entirety.

The most common method of carcass disposal is by burial. So that this method will be effective, the carcass should be buried deep and covered with quicklime. The top of the carcass should be at least four feet below the surface of the ground and in soil from which there is no danger of contamination by drainage. Burial should not be near a flowing stream, for this will only serve to spread the disease downstream. Near large centers of population, rendering plants will take carcasses, and they afford the easiest method of disposal.

When an animal dies, it is recommended that a veterinarian be called immediately to perform a post-mortem examination. This is done in an attempt to determine the cause of death or study the abnormal conditions present. It is never safe for one who is uninformed about specific disease lesions to open an animal carcass. Such practice may not only serve to spread a very highly contagious disease but may also expose the operator to a dangerous infection.

It is also unsafe to feed the carcass to other animals. Such procedure may cause the animal consuming it to become sick, or it may serve only to spread the disease.

DISINFECTANTS AND THEIR USE:

A disinfectant is defined as any biological, physical, or chemical agent capable of exerting changes in environment unfavorable for the continued survival of micro-organisms.

Under ordinary conditions, proper cleaning of barns removes most of the micro-organisms, along with the filth, thus eliminating the necessity of disinfection. In case of disease outbreak, however, the premises must be disinfected.

Disinfection must in all cases be preceded by a very thorough cleaning, for organic matter serves to protect disease germs and otherwise interferes with the activity of the disinfecting agent. This includes the burning of all inflammable refuse and the spreading out of the remainder on arable land (cultivated land not occupied by animals). Included also is the moistening of all litter and its subsequent removal. All walls, ceilings, and wood work must be brushed down and also washed down with water

and scrubbed. Old sacks should be disinfected or destroyed. Contaminated feed should be destroyed. Having accomplished this cleaning, one is ready to choose the disinfectant.

Unfortunately, there is no one best germ killer nor is there anything like a "general disinfectant" that is effective against all types of micro-organisms under all conditions. This stems partially from the fact that not all disease-producing bacteria are susceptible to the same chemical agents. A few bacteria—such as those which cause blackleg, tetanus, and anthrax—possess the ability of forming seed-like spores that can remain dormant for years and resist destruction. Others, like those organisms causing tuberculosis, are resistant to oxidizing disinfectants such as the chlorine compounds.

The organisms that cause brucellosis, strangles, and some other diseases are, fortunately, very readily killed by almost any disinfectant that reaches them. Sunlight possesses disinfecting properties, but it is variable and superficial in its action. Heat and some of the chemical disinfectants are more effective.

HEAT

The application of heat by steam, hot water, or by burning and boiling is an effective method of disinfection. Boiling is so simple that it is almost forgotten. Very few organisms can withstand boiling water; and if they can, they would probably not be killed by ordinary concentrations of common disinfectants. Moist heat is preferred to dry heat, and steam under pressure is the most effective. Heat may, however, be impractical, or be too expensive and thus give way to chemical disinfection.

CHEMICAL DISINFECTION

In introducing chemical disinfection, it might be well to give a brief statement relative to the "phenol coefficient." This designates the value of a disinfectant and refers to the times the product can be diluted more than phenol (carbolic acid) and still retain equal disinfecting value. It is a standard laboratory test in which the typhoid fever germ is used as the test organism. Although this method of evaluation is useful, it is not always a reliable index, especially when the organism is unlike the typhoid bacteria and the disinfectant is not like carbolic acid.

Table 11 gives a summary of limitations, usefulness, and strength of some common chemical disinfectants.

TABLE 11

SUMMARY OF LIMITATIONS, USEFULNESS, AND STRENGTH OF SOME COMMON CHEMICAL DISINFECTANTS

Name	Limitations	Usefulness	Strength
Lye	Damages fabrics, aluminum, and painted surfaces. Not effective against organism of T.B. or most spores.	Against brucellosis organism. On concrete floors.	1 can (13 oz.)/12-15 gallons water.
Cresol	Where odor may be absorbed; or against spores.	Against tuberculosis and hog cholera.	4 oz./gallon
Quicklime	Not effective against spores and acid-fast group of organisms.	On manure and animal discharges and as a deodorant.	As dust or as newly-made whitewash.
Hypochlorites	In presence of organic matter, not effective against organism of tuberculosis or spores.	For deodorizing manure, sewers, drains, and around the dairy.	200 parts available chlorine per million water.
Iodine	Never placed under a bandage.	Disinfection of minor cuts and bruises.	NAI 2.4 gm. Iodine 2.0 gm. Alcohol 47%, 100 cc. or strong tincture KI 5 gm. Iodine 7 gms. Alcohol 83% 100 cc.

SOAP

The action of soap depends most upon its ability to cleanse and dissolve protective coatings from various surfaces. Its power to kill germs is very limited, and it cannot be relied upon to destroy resistant organisms. Cocoanut oil or so-called "salt water soaps" possess the greatest (though limited) disinfecting value.

LYE

Lye, or caustic soda as it is often referred to, is an inexpensive and highly effective disinfectant. Chemically, lye is hydroxide of soda, or hydroxide of potash, or a mixture of the two. It can be used by dissolving one can of lye (13 ounces) in 12 to 15 gallons of cold water. It is recommended on concrete floors of barns and milk houses because it is an efficient cleaner and leaves no odor. It is effective against micro-organisms of brucellosis and the viruses of foot-and-mouth disease and hog cholera. It does, however, possess some definite limitations. It is not effective against acid-fast organisms, like the tuberculosis bacteria, nor against the gram-positive organisms, like the one that causes strangles

in horses. Lye is also destructive to paints, aluminum, and wool and silk clothing. A lye solution is also slightly irritant to the hands and face, unless protected by cold cream or other oily substance. Diluted vinegar can be used to neutralize the lye. No containers of lye should be left unguarded within reach of animals. It is a mistake to add any coal tar disinfectant, such as lysol, to lye solutions; for a neutralization occurs, which reduces the germ-killing power of both lye and coal tar disinfectant.

QUICKLIME

Chemically this is calcic oxide. It is also known as burned lime.

Quicklime is a common disinfectant used for sprinkling on the floor or as white-wash. When scattered as a dry powder, quicklime is valuable as a disinfectant on moist surfaces. It is recommended as a deodorizer on manure and on decaying animal and vegetable matter. The addition of water to quicklime produces a disinfectant capable of killing most dangerous microorganisms, except those like the tuberculosis bacteria and the spore formers.

White-wash made from quicklime is effective only when used immediately, otherwise the carbon dioxide of the air will change it to calcium carbonate. Good formulas for white-washes may be obtained from various sources. One satisfactory form of white-wash may be made by adding 2¼ gallons of water to 38 pounds (½ bushel) of quicklime. The mixture should be strained through a fine mesh screen, and 7½ gallons of water in which has been dissolved 15 pounds of common salt should be added to it. This can then be thinned with more water. When applied as white-wash, this mixture does not exert any great influence as a disinfectant but does imprison much infectious material.

CRESOLS

Cresols are the carbolic-acid-like compounds that are chemically related but which differ in their disinfecting properties. They possess a very pungent "sheep-dip" odor that often restricts their use, because this odor is absorbed in milk and meat. Orthophenyl-phenol is an exception, being free from objectionable odor. Carbolic acid (phenol) is not recommended because it is too expensive and not powerful enough in usable concentrations.

Commercial cresol is most generally used in mixtures with soap and in that manner is effective against hog cholera (phenol is not) and against tuberculosis organisms. When used against

the latter organisms, it seems to dissolve off the waxy coating. Saponified cresol is employed mostly in water solution at the rate of 4 ounces to 1 gallon of water. It is to be cautioned that cresols are limited in hard or mineral waters and that they lose most of their efficiency when mixed with an abundance of soap.

CHLORINE

Some chlorine compounds are used extensively on the farm. The hypochlorites are rapid in germ killing power and fairly reliable and safe, although not effective against the tuberculosis organism. Also their effectiveness is very largely reduced in the presence of organic matter.

The effectiveness of chloride of lime (bleaching powder) is similarly reduced in the presence of organic matter, although it is used in the disinfection of sewers and drains. For disinfecting manure, it must be used in considerable quantities.

BICHLORIDE OF MERCURY

This substance, which is also known as corrosive sublimate, has been used for many years. The typical coffin-shaped tablets are a familiar sight, used in a dilution of 1 to 1000. Although it has been depended on a great deal in the past, actual tests show bichloride of mercury to be unreliable as a germ killer in the presence of organic matter. In addition, cattle are especially susceptible to mercury poisoning. For farm disinfection, bichloride of mercury is classed as inferior to disinfectants like iodine, lye, saponified cresols, and the new cationic bactericides.

BORIC ACID

Although formerly considered a mild and safe germ killer, boric acid has been carefully investigated and found wanting. It is practically worthless as a germ killer and may cause harm to the nervous system if absorbed into the body in large amounts.

CATIONIC BACTERICIDES

Cationic bactericides are a class of relatively new complex chemicals. They have only a slight toxicity and are nonirritant and odorless. Preliminary investigations reveal that they are equal in their killing power to the chlorine compounds on clean surfaces and somewhat superior to them in the presence of organic matter. Their disadvantages are their higher price per unit and their peculiarity of being neutralized by soap or the new soap substitutes referred to as anionic detergents.

IODINE

In alcoholic solution, iodine is very reliable, and it is extensively used as a skin disinfectant. The new tincture of iodine is almost as effective as the old tincture and is far less irritating and harsh to the tissue.

ALCOHOL

Grain alcohol is sometimes used as a disinfectant. Laboratory tests have shown that it is effective against the less-resistant disease germs, such as those that cause typhoid fever. For effective germicidal value, this disinfectant should contain 70 per cent alcohol—the content usually found in "rubbing" alcohol.

Regulations Relative to Disease Control

Certain animal diseases are so devastating that no individual farmer or rancher could long protect his herds and flocks against their invasion. Moreover, where human health is involved, the problem is much too important to be entrusted to individual action. In the United States, therefore, certain regulatory activities in animal-disease control are under the supervision of various federal and state organizations. The duties and responsibilities of some of the more important of these agencies will be discussed briefly.

BUREAU OF ANIMAL INDUSTRY:

The year 1884 marked the beginning of an organized cooperative effort, under legal authority, for the control and eradication of animal disease. In this year, Congress passed an act creating the Federal Bureau of Animal Industry. It was first established to prevent exportation of diseased cattle and to eradicate contagious pleuropneumonia and other contagious diseases. In three years, it had succeeded in completely eliminating contagious pleuropneumonia, a dread disease.

In famous bulletin No. 1, the Bureau of Animal Industry revealed that Texas fever ticks were the biological bearer of the protozoa causing Texas fever. The description of this type of disease relationship laid the foundation for the subsequent work on such diseases as yellow fever and malaria of humans.

Since then, great progress has been made. To list a few examples, bovine tuberculosis has all but been eradicated, and the cattle tick fever has been reduced to negligible proportions by a very extensive eradication program. Present immunization methods have brought under control much of the devastation formerly

wrought by hog cholera. Advances are being made on the control of brucellosis and mastitis. In addition, there are many methods by which the Bureau of Animal Industry makes less spectacular, though equally important, contributions to human and animal welfare in the United States.

STATE VETERINARIANS, SANITARY COMMISSIONS, AND BOARDS:

In addition to the work of the U. S. Bureau of Animal Industry, most states have state veterinarians, or comparable officials, who also direct their effort to livestock sanitary and regulatory problems.

QUARANTINE:

By quarantine is meant the segregation and confinement of one or more animals in the smallest possible area to prevent any direct or indirect contact with animals not so restrained.

Many highly infectious diseases are prevented from gaining a foothold in this country by strict enforcement of local quarantine at points of entry. By such means rinderpest, surra, and other diseases have never gained a foothold in the United States. When an infectious disease outbreak occurs, drastic quarantine must be imposed to restrict movement out of an area or within areas. The type of quarantine varies from one involving a mere physical examination and movement under proper certification to the complete prohibition against the movement of animals, produce, vehicles and even human beings.

STOCKYARDS INSPECTION:

With the advent of large public markets, public stockyards inspection was initiated. This is an addition to the regular inspection performed on animals by meat inspectors prior to slaughter. Among the principal diseases for which inspections are made are anthrax, scabies of cattle and sheep, tick or splenetic fever, hog cholera, and erysipelas of swine.

Not only are the incoming shipments of livestock inspected, but a reinspection is made of outgoing shipments. Tests for tuberculosis and brucellosis are accomplished, and dipping for scabies and immunization for hog cholera are performed before shipments are allowed to return to farms and ranches.

MEAT INSPECTION:

Federal meat inspection is required by law for all meat and meat products prepared for interstate commerce. Its purpose is to

protect the consumer against infected meats and fraudulent and unsanitary preparation of meat products. The inspection first consists of an examination of the live animal so that any unfit beast may be removed and properly disposed. Secondly, the carcasses and internal organs are inspected for any abnormalities of animals carrying infectious diseases. Centers of infection sources may be located, thus assisting the livestock owners in the vicinity. The records of meat inspection also serve as a useful purpose to the research scientist. Additional discussion of meat inspection is contained in Chapter VII.

BIOLOGIC STANDARDIZING:

Regulations now in effect are designed not only to standardize but to improve the quality of biological products and drugs of licensed establishments. Considering the millions of inoculations that are made each year, it is not difficult to imagine the havoc that could be wrought by infected products. It is required that the products be of standard quality and properly labeled.

References

Further information relative to specific diseases and parasites affecting each of the respective classes of livestock is presented in the following books by the same author and the same publisher as *Animal Science:*

Beef Cattle Husbandry

Sheep Husbandry

Swine Husbandry

Horse Husbandry

CHAPTER VI

MARKETING LIVESTOCK[1]

When animals were first domesticated in different parts of the world, and for many years thereafter, nearly all the people lived on the land. There were no large cities, and, consequently, there was no need for any livestock marketing system. Each family did its own slaughtering and either consumed the fresh



Fig. 73. Two Egyptian cattlemen taking an ox to market. (An old photograph from Bas Relief found in Sakara in the tomb of King Ephto Stoptep.) At first, meat animals were bartered for articles made by craftsmen. Eventually, bartering gave way to cash sales as coined money began to circulate. **(Courtesy, The Bettmann Archive.)**

meats or dried, smoked, or salted them for later use. Then as crude manufacturing developed in various countries, the keepers of the herds and flocks established trails across the mountains and deserts to the more populous valleys or seaports, where they might barter meat animals, wool, and skins for articles made by craftsmen. Eventually, bartering gave way to cash sales as

[1] In the preparation of Chapters VI, VII, XV, XXIII, and XXXII, invaluable criticisms and suggestions as to organization and content were received from the following reviewers: Mr. H. R. Morman, Armour and Company, Ogden, Utah; Mr. Howard White, Wilson and Company, Denver, Colorado; and Dr. Fred J. Beard, Chief, Standardization and Grading Division, Production and Marketing Administration, U.S.D.A., Washington, D. C.

coined money began to circulate. Finally, as further specialization developed and it was necessary for livestock producers in the more isolated and distant areas to provide slaughter animals for the city dwellers, livestock markets and slaughtering plants evolved in different sections of the world.



Fig. 74. Old-time farm slaughter scene. When nearly all the people lived on the land—prior to the growth of cities and the rise of the town butcher—each family did its own slaughtering and either consumed the fresh meats or dried, smoked, or salted them for later use. (Courtesy, Swift and Company.)

Although the pattern of development has been very much the same in countries that made the shift, the completeness of the transformation has varied considerably, and some countries have even remained on a home-produced and home-cured basis. Thus, even in this atomic age, modern transportation, refrigeration, central livestock markets, and packing plants are unknown in many parts of the world.

THE DEVELOPMENT OF AMERICAN MARKETS

Until the latter part of the seventeenth and early part of the eighteenth centuries, American livestock markets were small and largely local in character. At that time, the "West" was comprised of Ohio, Kentucky, and Indiana. There were no railroads, no refrigerator cars, and no large central markets. For the most part, meat animals were slaughtered on the farm, and the carcasses were exchanged for the goods and services supplied by the artisans and tradesmen.



Fig. 75. The first Swift and Company "packing plant." Small, local slaughter houses of this type were the forerunners of modern packing houses. (Courtesy, Swift and Company.)

As the eastern seaboard towns and cities became larger, direct barter between farmers and consumers was gradually replaced by the services of the local meat merchant. For a time, however, slaughtering continued to be done on the farm. The town meat merchant merely served as a middleman, buying the dressed carcasses from farmers and selling the meat to consumers and sometimes curing a portion of it for later use. But because farmers often slaughtered on a convenience basis rather than according to the demand, less reliance was placed upon farm slaughter as the requirements for meat increased. This gave rise to the town butcher who purchased animals on the hoof, slaughtered them, and distributed the meat. In the begin-

ning, his slaughter plant and selling place were located together, and most of the house-to-house selling was done by means of a little covered one-horse butcher's cart.

With this transformation, it was an easy and logical step for the slaughtering houses to be operated under separate ownership and for one such plant to take care of the slaughter needs of more than one meat market. Thus, these local slaughter houses gradually increased in size and importance. They were the forerunners of the modern packing plants.

As the volume of slaughtering increased, the operators no longer had the necessary time in which to go greater distances into the country for the purposes of buying slaughter animals. They found it more convenient to depend upon "drovers" who purchased animals in the country, assembled them, and trailed them to the local slaughter houses. These early livestock, "drovers" operated as employees of the slaughterer, employees of the butchers, or operated on their own account. They were called "drovers" because the major portion of their time was spent in driving slaughter animals from farm to market. A few hundred miles travel meant nothing to these men whose lives were filled with adventure and hardship. Often they forded or swam their herds across dangerous streams, braved storms and thieves, and overcame difficulties which would have driven men less resolute out of business. These "drovers" were truly the pioneers of livestock transportation.

As production areas shifted farther westward, increasing numbers of cattle, hogs, and sheep were driven overland from the newly settled areas to the expanding eastern cities. But there were no market reports, and communication was largely by word of mouth. Thus it was mere happenstance if supply and demand coincided in any reasonable degree. Most generally, there was either a vast oversupply or too few animals available. The situation between different markets also usually varied at any given time, even though they might not be separated by many miles. In addition to these complications, "drovers" often found it difficult to get in touch with prospective buyers. This led to the establishment of private markets in close proximity to the larger cities.

In the private markets, livestock were assembled, and buyers and sellers met. In some instances, special market days were designated for the convenience of both the buyers and sellers. The more enterprising market operators provided feed and water

for the animals, and served as go-betweens for the buyers and sellers. In due time, Baltimore, Philadelphia, New York, Albany, and Boston became rather large markets.

Out of this humble beginning, a huge American industry evolved. Today, the task of marketing—which is merely one phase of the livestock business—is astounding. For example, during the five-year period ending in 1946, livestock growers and feeders marketed a total of 693 million cattle, hogs, and sheep, or an average of 380 thousand meat animals every twenty-four hours. In 1946, the stream of animals that moved to market provided a cash income of 6 billion, 900 million dollars—an average of about 18.8 million dollars per day. This income represented about 28 per cent of America's total farm income.

THE DEVELOPMENT OF LIVESTOCK TRANSPORTATION

In no phase of livestock marketing have the developments been more phenomenal than in transportation. With the humble beginning of marketing on foot or by a combination of trailing and boat transportation, transportation has progressed to the luxury of the railroad, to the development of the refrigerator car designed for carrying and preserving fresh meats, and finally to the construction of modern highways and the speed and flexibility of the motor truck.

Trailing or Droving

The story of trailing or droving constitutes one of the most fascinating chapters in the development of the West. Shortly after the Revolutionary War, the pioneers pushed farther to the west, where they found rich farming lands in the area now known as the central states. But there were no markets for the crops they grew. A bushel of corn in the Ohio Valley sold for one-fourth the price of corn in Philadelphia. Moreover, the town craftsmen of the rapidly growing industrial East demanded meat and sufficient of this product could only be obtained from now distant areas. Transportation was the major problem. There were no railroads, and water transportation had its geographical limitations. The solution was more livestock that could be fattened and then driven overland to livestock markets in the East where the surplus grains and forages could be marketed on four legs. This gave rise to the movement of animals by trailing.

Perhaps trailing of cattle, sheep, and hogs was prompted by the earlier success that Kentucky horse raisers experienced in driving horses to South Carolina. The horses were taken

droves of from fifteen to thirty, with the journey from Lexington to Charleston requiring from eighteen to twenty days. For these services, higher prices of from 20 to 30 per cent were realized.

In 1805, against the advice of his neighbors, George Renick, a prominent farmer in the Scioto Valley, of Ohio, selected sixty-eight of his best steers, which he started across the Allegheny mountains. This herd was driven the 350 miles from the Ohio farm to Baltimore, where they were disposed of at a handsome profit. This successful venture served as a great impetus to the cattle, sheep, and swine production of the West, for a market



Fig. 76. Texas cattle fording a stream in "trailing" north. A few hundred miles travel meant nothing to the "drovers"—those men who drove slaughter animals overland to eastern markets. Their lives were filled with adventure and hardship. These drovers were truly the pioneers of livestock transportation. (After a woodcut. Courtesy, The Bettmann Archive.)

was now assured. Thereafter, travelers frequently met droves of Ohio animals trailing east. In 1817, an Ohio farmer named Drenning drove two hundred head of cattle from Chillicothe, Ohio, to New York. These were the first western cattle to reach that market. Although they were driven nearly one thousand miles, they were reported to have arrived in excellent condition.

Two grades of cattle were driven to the East. Three-year-old steers, called "stock cattle," were taken to eastern Pennsylvania, where the farmers bought and fattened them prior to slaughter. Fat four-year-old bullocks were driven more slowly and sold directly to the butchers, principally in New York, Philadelphia, Boston, and Baltimore.

The crew of drivers usually consisted of the boss (often the owner of the herd), a man to ride along each side, and a fourth man to lead. Sometimes the "lead man" led an ox as a sort of "bellweather for the herd." A whip, which an experienced drover could crack like a rifle shot, completed the driving equipment. The hired drovers received an average of $15.00 per month. Enroute, at intervals, were "drove stands," which were the inns or rather large farmhouses where the drovers lodged. The inns were surrounded by cattle pens and corn cribs.

Usually, the animals were trailed ten to twelve miles per day. The routine drive consisted of allowing the stock to graze in the proper direction for a couple of hours during the early morning, driving slowly until noon, halting for two or three hours of rest and quiet early in the afternoon, and finally allowing the animals to again graze in the proper direction before being bedded down for the night. When handled in this leisurely manner, the cattle suffered little shrinkage while enroute. Indeed, if the vegetation was good along the way and the drovers were careful, it often happened that the animals arrived at their destination in better condition than when they left the farm.

Often before the destination was reached, the drover was met by speculators who, knowing the condition of the market better than the drover, frequently made shrewd bargains. Upon arrival at the market, the animals were grazed on the public or semipublic land adjacent to the city until disposed of to the city butchers. The standard cattle price at the time ranged from $20.00 to $35.00 per head, with sheep and hogs bringing less in proportion to their size.

Cattle, sheep, and hogs were driven over these famous trails, many hundreds of miles long. Around such drives center many of the most romantic incidents of American history. They were accompanied by an almost ceaseless battle with the elements, clashes with thieves and other drovers, and no small amount of bloodshed. But the historical records are all that remain today. The trails are gone and the "longhorn" and the large, active, long-legged hogs, and sheep of that era have given way to animals of superior breeding less adapted to travel on foot.

Water Transportation.

With the opening up of the West, the major portion of the animals were marketed by trailing. Water transportation was slow and restricted geographically. Yet shipping by boat down the Mississippi and Ohio and up the Atlantic coast provided

a limited outlet for both live animals and cured meat. With the growth of water transportation on the Great Lakes and the development of numerous canals, some animals and cured meats were shipped at least a part of the distance to the East by this method.

Today, inland water transportation is not considered sufficiently rapid or ideal for extensive movement of either livestock or fresh meats. As an example of the decline in water transportation, it is interesting to note that boat receipts of cattle at East St. Louis totaled 65,000 head during the three-year period 1865-67 and 46,000 head during a like period from 1905-07. Since 1932, however, no stock boats have operated at this market. In period of time, this change followed closely the development and extension of the railroads. Inland water transportation finally passed into permanent oblivion with the coming of truck transportation. Some fresh and processed meats are exported to other countries via fast steamers, equipped with refrigeration, but fat animals are seldom exported on foot. An exception exists, however, in the limited numbers of butcher hogs that are shipped to Hawaii.

The Advent Of Transportation By Rail

The luxury of rail transportation marked a turning point in the production and marketing of livestock. The first major cattle shipments by rail of which there is record were made in 1852. One hundred cattle had been trailed from Lexington, Kentucky, to Cincinnati, Ohio, where they were loaded on crude cars and shipped to Buffalo. Here they were again unloaded and trailed to Canandaigua, New York, where they were loaded on cars and shipped to Albany. After resting two days at Albany, they were shipped by steamer down the Hudson to New York. The one-thousand-mile journey required only two weeks, despite the many shifts. The total transportation expenses were around $14.00 per head, reported as less than the cost of trailing. And besides, the cattle arrived in better condition than when they were trailed the entire distance.

Two years later, in 1854, the Pennsylvania railroad improvised cattle cars from flat cars upon which fuel wood was usually transported. This crude car had slatted sides, but no roof. Entrance was gained from the side by lifting a section of the slats hung on hinges. Boards were placed across the top to serve both as a roof and a place upon which to carry feed.



Fig. 77. Unloading cattle at railroad unloading dock. Union Stock Yards, Chicago. Cattle were first shipped by rail in 1852. The day of the drover ended with the advent of the railroads. (Courtesy, The Union Stock Yard and Transit Company, Chicago, Illinois.)

The period between 1850 and 1860 was one of feverish activity in railroad construction throughout the central west. With this expansion, producers demanded more and improved facilities better adapted to the marketing of animals. This led to improvements in the type and construction of the cars, including increased carrying capacity and roofs to prevent animals from jumping out and to provide added protection from the weather, less injury hazard, and arrangements for feeding enroute. In 1860, the first doubledeck car was developed for the transportation of hogs and sheep.

By 1860, the railroads extended west of the Mississippi and the Corn Belt states became the great cattle and hog feeding districts. This was followed by the opening up of the western range, beginning about 1870 and reaching its maximum development between 1890 and 1900.

The supremacy of the railroads over trailing and water transportation was due to: (1) greater speed and efficiency, (2) more dependable year-round service, and (3) the fact that the railroad lines were not so severely limited to the topography of the country as water transportation. As a result, the railroads were the principal agency used in the transportation of livestock to market from the latter part of the 1850's to the advent of the

motor truck. The day of the drover ended with the advent of railroads. Today, the word "drover" is practically obsolete, except that it is used in the names of some of the old-established stockyards institutions, such as drovers' banks and drovers' hotels.

THE DEVELOPMENT OF THE REFRIGERATOR CAR:

The word "packer" is derived from the fact that, prior to the development of refrigeration, the meat processor was one who packed or put down cured meats, chiefly pork. The perfection of artificial refrigeration completely revolutionized the methods of handling meat products and the marketing of meat-producing animals. As a result, livestock could be slaughtered throughout the year rather than just during the winter months, and the fresh meat could be transported great distances via refrigerator cars. Artificial refrigeration also made it possible to slaughter the live animals near the area of production and to ship the fresh dressed carcasses to the more distant consuming centers. This brought about a shift of the major central markets and packing centers from the North Atlantic states to the Mississippi Valley.

Packing of pork in the summer was first begun in 1857, and ice was used for cooling purposes. However, the first really large-

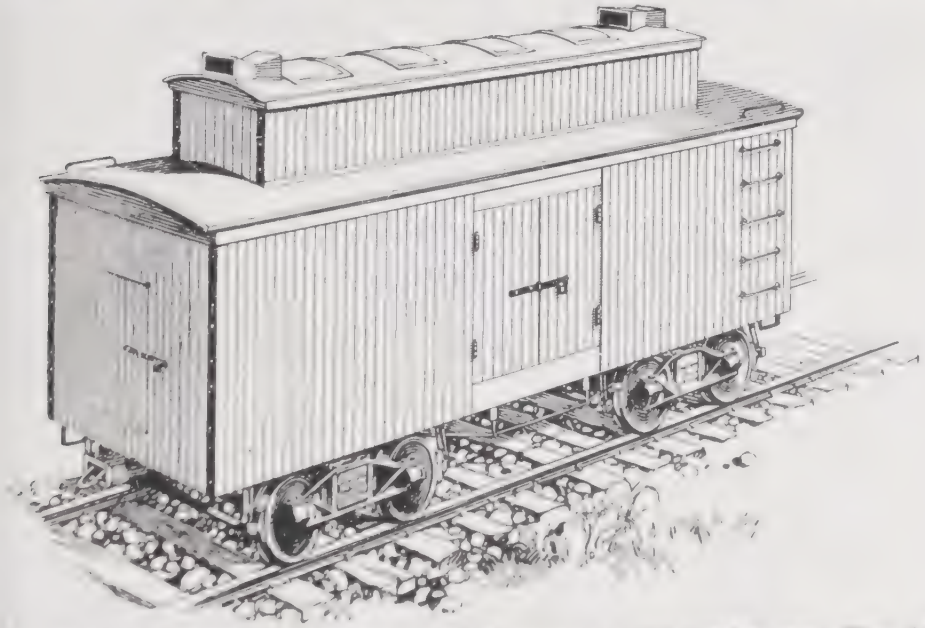


Fig. 78. Early-day Armour and Company refrigerator car. The first refrigerator car was invented in 1868, but successful rail shipment of fresh meat by refrigeration was not achieved until 1871. Artificial refrigeration revolutionized the livestock marketing and meat packing industry. It made it possible to slaughter the live animals near the area of production and to ship the fresh dressed carcasses to the more distant consuming centers. (Courtesy, Col. E. N. Wentworth, Armour and Company, Chicago.)

scale chill room in the world was erected in Chicago by Philip D. Armour in 1875. The first refrigerator car was invented in 1868, and the following year an unsuccessful attempt was made to ship a consignment of dressed beef from Chicago to Boston. G. H. Hammon, of Detroit, first successfully shipped fresh beef by refrigerator car from the Midwest to eastern markets in 1871. In 1875, Gustavus F. Swift, the founder of Swift and Company, fitted up a refrigerator car and shipped meat east successfully. Two years later, in 1877, Swift had ten refrigerator cars built to his own specifications. Thus, beginning about 1875, the use of the refrigerator car became an established part of the meat packing industry. This car eliminated the freight charges on all the inedible portion of the animal, the shrink in transit, the expense of feeding and watering enroute, and the losses in bruises, crippling, and death. No longer was slaughtering restricted to the winter months, and fresh meat rapidly replaced much of the cured and dried products of the early day packer.

NUMBER OF ANIMALS IN A RAILROAD CAR:

Normally, railroad cars are either 36 or 40 feet in length. The size of the car and the class and size of animals determine the number of head that can be loaded in a given car. For comfort in shipping, the car should be loaded heavily enough so that the animals stand close together, but over-crowding is to be avoided. Table 12 gives some indication as to the number of market animals that may be loaded in a railroad car.

TABLE 12

ANIMALS PER RAILROAD CAR[1]

Car size	Kind and weight of animals		
	Cattle, 1,000 pounds	Hogs, 225 pounds	Lambs, 90 pounds
36 foot car	25	73	112
40 foot car	27	82	124

[1]Hogs and lambs per single deck.

MODERN TRANSPORTATION BY RAIL:

In recent years, railroads have granted numerous concessions to livestock producers with a view to meeting motor truck competition. These considerations include local assembly by motor truck, more favorable rates on less than carload-lot (LCL) shipments, and liberal unloading privileges enroute. Also, to their everlasting credit, the railroads have long supported and ad-

vanced progressive livestock programs, both through their own competent personnel and in cooperation with the state agricultural colleges. Without doubt, the future trends in the proportions of livestock shipped by rail and motor truck will depend upon the relative convenience, cost, and efficiency of service rendered by each.



Fig. 79. Unloading hogs at truck unloading dock, Union Stock Yards, Chicago. Market animals were first shipped by motor truck in 1911. By 1935, trucks were used in transporting more than half of the livestock delivered at the central markets. Rail shipments predominate when long movements are involved, whereas truck shipments are favored for short hauls. (Courtesy, Union Stock Yard and Transit Company, Chicago, Illinois.)

Transportation by Truck

Transportation by truck is the most recent development in the livestock field. The first market shipment of livestock by motor truck was made on July 25, 1911, when a consignment was unloaded at the Indianapolis Market. Other shipments followed at this and other markets, and, with improvements in both highways and trucks, this method of transporting livestock increased in importance. By 1935, trucks were used in transporting more than half of the livestock delivered at the central markets. In market receipts, truck shipments are referred to as "drive-

in" receipts because formerly they were either driven into the yards or hauled in wagons. The term "drive-in" distinguishes them from rail shipments.

There are wide variations in the proportion of livestock arriving by motor truck at different markets. In general, a higher proportion of hogs and calves than cattle and sheep arrive by motor truck. In a study involving more than sixty leading central markets,[1] it was reported that 71 per cent of the cattle, 74 per cent of the calves, 76 per cent of the hogs, and 44 per cent of the sheep and lambs, were delivered by motor truck in 1949. Rail shipments predominate when long movements are involved, whereas truck shipments are favored for short hauls. The latter point probably explains why a lower percentage of sheep and cattle are transported by truck, for longer shipments are involved for these animals, especially with western-range consignments.

Table 13 shows the percentage of total livestock receipts at several leading central markets received by rail versus truck.

TABLE 13

PERCENTAGE OF TOTAL LIVESTOCK RECEIPTS OF SEVERAL CENTRAL MARKETS AND OF 66 U. S. MARKETS RECEIVED BY RAIL VERSUS TRUCK, 1948[1]

(in per cent)

Truck or rail	Chicago	Omaha	Kansas City	St. Louis	Sioux City	Total of 66 U. S. markets
Rail	37.5	31.9	54.7	21.5	17.4	35.9
Truck	62.5	66.1	45.3	78.5	82.6	64.1

[1] *Agricultural Statistics, 1948, U. S. Dept. of Agri.*, 1949, pp. 354, 368, and 383.

As will be noted, Sioux City receives most of its shipments by truck, whereas Kansas City is primarily on a rail-shipment basis. The preponderance of rail receipts at Kansas City is due, in part, to the large number of feeder cattle shipped to this market from the ranges of the West and Southwest.

ADVANTAGES OF TRUCK TRANSPORTATION:

The most common reasons advanced for the marked increases in motor truck shipments are the following:

1. **Greater convenience.**—Trucks permit loading animals at the farm or ranch and moving directly to the final destination. Also, in comparison with rail shipments, truck transportation is more elastic from the standpoint of size of load, routes, and

[1] *Livestock Market News, Statistics, and Related Data*, U. S. Dept. of Agri., July, 1949, 16.

schedules. Trucks vary in size from the standard pick-up to the semitrailer-type, with a load capacity equal to the standard 36-foot railroad car. In the case of rail shipments, it is necessary to order the car in advance (and a 36-foot car is the smallest size), to haul or drive the animals from the farm or ranch to the shipping point, to bed and load the cars, and to consign the shipment to the designated market. Much of this inconvenience is eliminated in truck transportation.

2. **Lower transportation charges on short hauls.**—With the extension of good roads and improvement in the size and type of motor trucks, lower transportation costs have followed. This is particularly true when short hauls are involved.

3. **Greater flexibility of time and place of marketing.**—Progressive farmers and ranchers follow market quotations very carefully, often loading out by truck after getting an early morning market-news report. Motor trucks also can move in any direction, thus making available an increase in the number of outlets.

SOME EFFECTS OF TRUCK TRANSPORTATION ON MARKETS:

The development of truck transportation has had two far-reaching effects upon the markets themselves. In the first place, it made for considerable change in stockyards management; and secondly, it favored decentralization of livestock markets.

1. **Change in stockyards management.**—Most central markets experienced the major part of their expansion prior to the advent of the motor truck. Their facilities were designed to handle a maximum of rail shipments and only a minimum number of "drive-in" truck receipts. Most of the unloading chutes were along railroad spurs; the pens and scales were designed to handle carload lots; and even their feed and handling charges were based on rail shipments.

With the shift to motor transportation, stockyard companies were put to great expense in remodeling. It was necessary to provide unloading facilities suitable for trucks; large pens had to be divided in order to provide facilities for the numerous smaller shipments; increased weighing facilities had to be installed; and more men had to be employed to do the work. Formerly, stockyard companies secured their income from two sources: (1) the yardage charge on incoming animals and (2) profit on the sale of feed. Because many producers prefer to sell "drive-in" animals without the fill—for the animals are in transit

only a comparatively short time—the source of profit from the sale of feed was materially diminished. Thus, it was necessary that the stockyard companies meet their increased operating costs by revising their yardage charges upward and feeding charges downward.

2. **Decentralization of livestock markets.**—So long as market animals had to be shipped by rail, producers favored their consignment to the larger central markets. But when truck transportation made it possible to ship in any direction, producers began to patronize the local plant. Truck shipment also was cheaper in the shorter hauls, especially when privately owned trucks were used and the nearby markets were more convenient for small producers. These factors definitely stimulated the growth of interior processing plants and started a marked trend toward decentralization of livestock marketing and slaughter. How far this trend will continue remains to be seen. It is reliably reported, however, that the extent of the decline in receipts is as high as 25 per cent of the 1920 volume at some of the larger markets.

THE DEVELOPMENT AND EXTENSION OF MEAT PACKING

The development of the livestock business has truly gone hand in hand with the transformation and extension of the nation itself, and progress in each phase of livestock marketing and processing has unwittingly stimulated the whole. Thus the growth of cities brought about the demand for meats. Progressively this was followed by farm slaughtering for barter, the establishment of the town butcher, the operation of the local slaughter house, the trailing of animals and the drover, the advent of rail transportation, the development of refrigeration, further opening up of the western range, improved highways, and shipment by motor truck. These changes were not alone, for the local slaughter house was gradually increasing in size and eventually we had the birth of the modern meat packing industry.

Early Meat Packing

Meat packing in colonial United States was originally for domestic purposes. During the winter months, each farmer slaughtered animals at intervals, consuming as much of it in fresh form as possible. But in order to have some meat available during the warmer months, bellies and hams were often salted and smoked, and beef was sometimes dried. The more enterprising farmers bartered their surplus production with the city

dwellers. The town butcher and the local slaughter house also did a limited amount of meat curing, chiefly as a means through which to handle any surpluses which they may have encountered. Eventually, certain individuals came to devote more and more time to meat curing. This practice received special impetus in 1641 when, because of the Civil War in England, the English

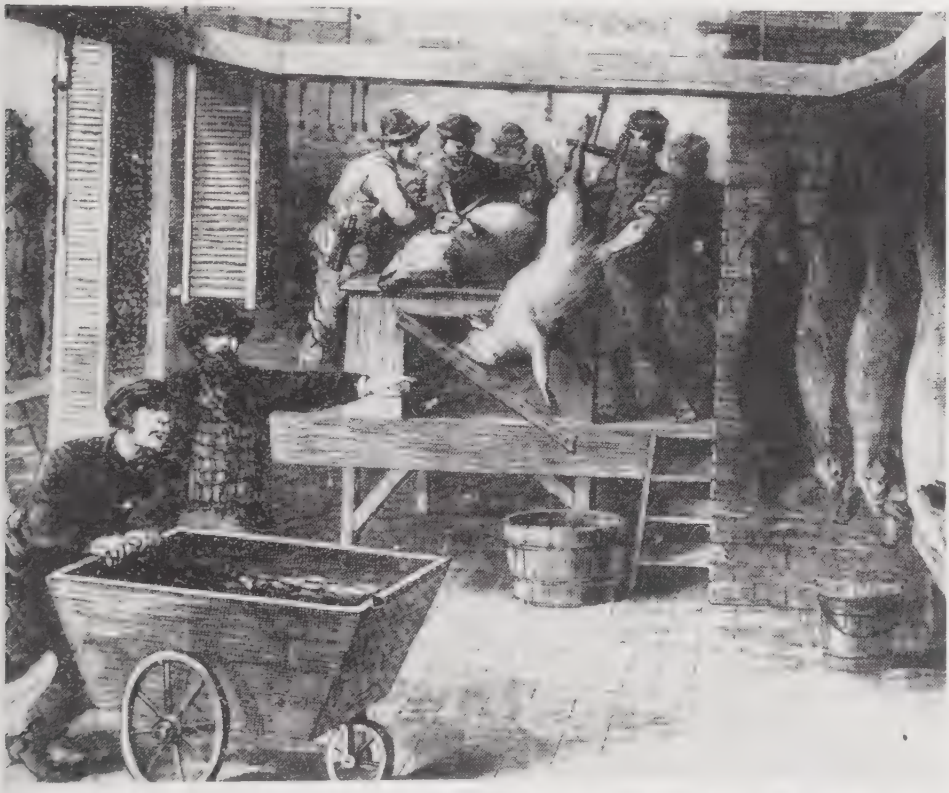


Fig. 80. Cleaning and dressing hogs in a meat packing plant at Communipaw, New Jersey, 1868. (Courtesy, The Bettmann Archive.)

traders could no longer supply the food needs of the British West Indies, and this lucrative trade was taken over by the colonists in New England, Virginia, and the Carolinas. The term "packer" was coined to designate those establishments whose chief business was that of putting down cured meats, mostly pork.

According to early records, the first American meat packer was William Pynchon, of Springfield, Massachusetts. He founded the city of Springfield in 1636. He dealt mostly in pork for the West Indian trade; but he also fattened cattle for the Boston market and dealt in mutton, tallow, and wool. Later, William Pynchon's son, John, greatly expanded the meat packing operations at Springfield.

Meat Packing Moved Westward

Gradually the centers of livestock production shifted to the West, whereas the East turned more and more to manufacturing and commerce, with great cities and thickly populated industrial centers. Meat production on a larger scale became necessary in order to supply the consumers. The Civil War, moreover, resulted in an unprecedented demand for meats to feed the soldiers at the front. The extension of the railroads and the development of the refrigerator car favored the development of more distant production and the growth of western markets. New markets sprang up in the West. At first many of these were scarcely



Fig. 81. Killing animals by the use of spears in the beef-sticking pens of an early-day meat packing plant. (Obtained from the Chicago Historical Society through the courtesy of G. B. Thorne, Wilson and Co., Chicago.)

more than concentration points where animals were sold and shipped on hoof to other markets for slaughter. But packing houses followed, and thus the foundation was laid for the great centralized markets of the present day.

With this westward march of the livestock industry, the leading markets shifted progressively from the eastern seaboard to farther inland. It was at one time believed that Albany was to be the final gateway for western shipment. Next Buffalo, Pittsburgh, and Cincinnati were in turn regarded as the future great livestock markets of the country; but eventually it became evident that Chicago—by virtue of its proximity to both the producer and consumer, and its railroad facilities—was destined to become the greatest central market in the world. It now appears that Omaha will continue to increase in importance as a central market.

Chicago Becomes A Meat Packing Center

The first slaughter house at Chicago was built in 1827. This plant was primarily operated for the purpose of supplying fresh meat to the garrison at old Fort Dearborn. No packing or curing of meats was done in Chicago until 1832, and it was not until the opening up of the Chicago and Michigan canal and the advent of the railroad that Chicago took prominence as a livestock center. Between 1850 and 1860, half a dozen independently owned stockyards sprang up in various parts of the city; and when these became glutted, the animals were grazed on the surrounding prairie until a price could be realized. Pickled pork and barreled beef, which were the staple articles of the packing plants of the day, were known to the trade under the unappetizing names of "sow belly" and "salt horse," respectively. It must be remembered, however, that prior to 1860, the railroads had merely taken their first faltering but uncertain steps; there were no motor trucks or improved highways; large-scale refrigeration and the refrigerator car were unknown; the trade in fresh meats was limited to the winter months; few by-products were used; the canning of meats had not been attempted; and Swift had not discovered Chicago.

Founding of the Union Stockyards At Chicago

According to historical accounts, a stockyard near Myrick's Tavern, three miles south of Chicago, was started in 1837. The Bull's head yard was opened in 1848, and several other small yards opened for business within the next eight years. Reports



Fig. 82. Early-day cattle market at Chicago, as portrayed in a woodcut of 1868. (Courtesy, The Bettman Archive.)



Fig. 83. Stone gate entrance to the Union Stock Yards, Chicago. In 1865, three railroads purchased 320 acres at 39th and Halsted Streets, and founded what was destined to be the world's greatest livestock market. (Obtained from the Chicago Historical Society through the courtesy of G. B. Tiedtke, Wilson and Company, Chicago.)



Fig. 84. View of the Chicago Stock Yards, the world's greatest livestock market. (Courtesy, Union Stock Yard and Transit Company.)

to the contrary, John B. Sherman did not found the present Chicago Union Stock Yards. Instead, in 1865, three railroad companies—the Michigan Southern and Northern Indiana; The Pittsburgh, Fort Wayne and Chicago; and the Michigan Central —purchased 320 acres at 39th and Halsted Streets, the present acreage and location of the Chicago Union Stock Yards. Other railroads immediately came into the picture, with the original board of directors including representatives of nine companies. At the time, Sherman was operating a private stockyard on the lake front and opposed the new consolidation strongly. Soon, thereafter, however, he sold out his business and moved east. In 1867, two years after incorporation, John B. Sherman was brought back as president of the Union Stock Yards Company. Gradually this market supplanted the seven scattered markets which existed at the time of its founding. Such was the humble beginning of what was destined to become the world's greatest livestock market.

Modern Meat Packing

Today the name "packing" is a misnomer, for the barreled or pickled pork from whence the name originated is now packed only for a few lumber camps and a limited export demand. But modern meat slaughtering and processing developed slowly, and the original name was so well established that there has never been any attempt to rename the industry.

ERAS IN THE EVOLUTION OF MEAT PACKING:

It may be said that there have been four distinct eras in the evolution of the modern meat packing industry: (1) the era of cured pickled pork and dry salted beef which correctly resulted in the early-day meat processors being designated as "packers"; (2) the era of rail transportation and the development of artificial refrigeration and the refrigerator car; (3) the era of complete utilization of by-products; and (4) the era of truck transportation of livestock and meat products.

The first era extends from the time when operators in the eastern cities first devoted the major share of their time to meat curing to approximately the time of the Civil War, a span of nearly two hundred years. The second era occupied a relatively short period of time, spanning only about two decades during and immediately following the Civil War. The era of the utilization of by-products was somewhat less rapid and devoid of much of the glamour of the first two periods. Truck transportation had its beginning in 1911.

NUMBER OF ESTABLISHMENTS AND SIZE OF THE MEAT PACKING INDUSTRY:

At first, the packing plants were local in nature and small in size. But as transportation facilities improved and the services were broadened, the plants increased in both numbers and volume of business. Today, there are four thousand meat packing companies—large and small, national, sectional, and local—in all parts of the country. In volume of business, the industry as a whole ranks as one of the big three, along with the automobile and steel businesses. It is also interesting to note that the meat packing concerns regularly provide about one-fourth of the nation's manufactured food products. The American meat processing industry, humbly originating with the home slaughtering and curing of the colonists, has thus risen to the status of big business. This position has not been achieved by mere chance but because of the services that these plants render to both the producer and the consumer.

SERVICES RENDERED OR FUNCTIONS OF MEAT PACKERS:

In a broad sense, the major service or function of the meat packing industry is to convert the available supply of slaughter animals marketed by farmers and ranchers into meat and other products desired by consumers, and to distribute these products in such manner as to satisfy most adequately the demand for

them. In executing this primary service, modern meat packing plants really render the following five distinct services or functions:

1. **The production of fresh meats.**—This involves the transformation of cattle, calves, hogs, and sheep into fresh beef, veal, pork, mutton, and lamb.

2. **The production of cured and processed meats.**—This production is given particularly to such pork products as hams, bacons, picnics, and Boston butts but it also includes a wide variety of sausage and canned meat items, corned and dried beef, and barreled pork and beef.



Fig. 85. A Swift and Company branch house. The nation-wide meat packing organizations maintain branch houses in the larger towns and cities. Here they receive their supplies in refrigerated cars and trucks directly from the meat packing plants, and they distribute their products to the customers in the area served. (Courtesy, Swift and Company.)

3. **The complete utilization of by-products.**—There is no waste; not a single element of value is discarded. Formerly, most of these products were wasted. They were carted away regularly and thrown into the river or dumped into trenches to be burned or buried. Today, cattle, calves, sheep, and hogs are a great deal more than food; they are the raw materials for a vast range of marketable and valuable by-products. For example, although the tiny glands of 60,000 cattle are required to produce a pound of pure, dry insulin, these glands are saved in the large plants. In brief, it may truly be said that a modern meat packing plant utilizes everything but the squeal.

4. **The transportation and efficient distribution of fresh and processed meats from areas of production to centers of consumption.**—In large nationwide meat packing organizations, this service is performed by maintaining a far-flung selling organiza-

tion in different cities. Deliveries are made through branch houses and refrigerator car routes.

The branch houses are company-owned selling agencies, located in the larger towns and cities. Each of these houses has refrigeration facilities, expert meat cutters and handlers, an accounting and credit organization, a sales force, and delivery equipment to carry the meats to the retailer's shop. These branches receive their supplies in refrigerated cars and trucks directly from the meat packing plants.

The thousands of smaller towns, which are not sufficiently large to support a branch house, are served by "car routes." That is, a refrigerator car or truck is sent over a specified route to supply several towns with their meat, dairy, and poultry products.

5. **The efficient handling of several other perishable products.**—Although meat is the principal product handled by the meat packing industry, the larger organizations distribute such products as poultry, eggs, butter, and cheese. The chief reason for dealing in these several products is that all of them are perishable, requiring essentially the same facilities for storage and distribution. Moreover, the multiple use of the facilities makes it possible to lower the cost of distribution of any one product. Thus, when beef and lamb carcasses are hung from the roof of a refrigerator car, the unoccupied space in the lower part of the car can be utilized effectively for transporting cured meat products or such products as require refrigeration. The shipment of poultry, butter, eggs, and cheese in such space adds weight to the car, promotes car efficiency, and increases the revenue per car.

EFFICIENCY AND LOW COST OF OPERATION:

In addition to rendering these many valuable services, the modern meat packing industry has become great because of the efficiency and relatively low cost at which it has operated over a period of years. According to the most reliable figures available, during the thirteen-year period extending from 1933 to 1945 and for an average of 617 reporting packing companies, the net profit on each dollar of sales of meat and other products amounted to a mere 1.1 cents—earnings of little more than 1 cent per dollar of sales. By contrast, the average earnings of all manufacturing industries during the same thirteen-year period as shown by statistics of income tax returns was 4.9 cents per dollar of sales, or nearly five times as great.

As further evidence of efficiency and low cost of operation in the meat packing industry, it is interesting to note that, during the twenty-one year period ending in 1945, the net profit of packing companies for each hundred pounds of live animal slaughtered was merely 13 cents; or on the basis of one hundred pounds of dressed meat, the earnings totaled 24 cents. Thus, based on averages, the packer for each one-thousand-pound steer purchased netted $1.30 in profit; for each two-hundred-pound hog, 26 cents; and for each one-hundred-pound lamb, only 13 cents. Naturally the volume of sales (the number of hams sold in a given year), the efficiency in operations, and the utilization of by-products make it possible for the industry to operate on these comparatively small margins.

Obviously, the net profits in the meat packing industry have never been large enough to have any appreciable effect upon either meat or livestock prices. The gross margin is too small. Consequently, there is no justification for the housewife blaming the meat packer for high meat prices. Neither is there any basis for the producer blaming the packer for low market livestock prices. This situation is largely true because of the keen competition within the industry and the thousands of meat slaughtering and processing plants located throughout the country.

It should also be realized that, however much the consumer may complain about the high price of meat, the price would be higher if it were not for the careful attention that has been given to the manufacture and sale of by-products. Many times the packer actually pays out for a live animal more than is received from the sale of the dressed carcass. Under these conditions, the 30 to 55 per cent non-meat portion of the live weight of a slaughter animal must be handled most efficiently in order to come out with any profit at all from the operations.

Geography of Meat Production and Consumption

About three-fifths of the livestock in the United States is produced west of the Mississippi River, whereas about two-thirds of the meat is consumed east of this area. Specifically, the geography of meat production and consumption as applied to each class of meat animals is as follows:

1. About 62 per cent of the cattle is raised west of the Mississippi, whereas about 70 per cent of the beef is consumed east of the Mississippi.

2. About 53 per cent of the hogs is raised west of the Mississippi, whereas about 70 per cent of the pork is consumed east of the Mississippi.

3. About 83 per cent of the lambs is raised west of the Mississippi, whereas about 78 per cent of the lamb is consumed east of the Mississippi.

Under these conditions, either livestock or meats, or both, must be moved great distances from the surplus-producing regions of the West to the deficit-producing areas of the East.



Fig. 86. Shows the geography of meat production and consumption. Note that the majority of production is in the West, whereas the majority of the consumption is in the East—thus making for a transportation problem. (Drawing by R. F. Johnson.)

From a practical standpoint, it has been found to be more economical to slaughter animals in plants located in close proximity to the surplus-producing sections, to save the by-products, and then to transport the meat in refrigerator cars to the consuming sections than to ship the live animals. Also, it is not economical to ship live animals farther than necessary on account of deaths, injuries, bruises, shrinkage, and freight costs. With this procedure the average pound of meat is moved about one thousand miles from where it is produced to where it is consumed.

The Four National Meat Packers

Certain names are synonymous with the packing industry. In 1863, Philip D. Armour, in partnership with Mr. Plankinton, established a meat packing enterprise at Milwaukee; and four years later Armour and Company set up business in Chicago. Gustavus F. Swift first opened a retail meat market of his own at Eastham, Massachusetts, in 1859; gradually he moved westward and opened up the Swift and Company, Chicago plant in 1877. The names of Armour and Swift, therefore, have long been landmarks in the meat packing industry.

Later, the Cudahy Packing Company and Wilson and Company rounded out the "Big Four." During the five-year period 1934 to 1938, the combined slaughter of the Big Four comprised 54 per cent of the cattle, 59 per cent of the calves, 47 per cent of the hogs, and 74 per cent of the sheep and lambs slaughtered in all wholesale slaughtering establishments in the United States. Of the total meat produced in pre-war years, about 42 per cent was obtained from animals slaughtered in the more than 85 plants of these four concerns. The efficiency of operation of the national meat packers is in the best interest of both the producer and the consumer. Through this efficiency, a higher price is obtained for animals on foot and meat is made available to the consumer at a lower price.

Decentralization of Meat Packing

Following World War I, a trend toward geographical decentralization of the industry became apparent. This represented attempts to seek the optimum plant location between supplies of livestock and the market for meat. These new plants are commonly referred to as "interior plants."

This gradual shift in location of slaughter has decreased the relative importance of some of the leading central markets. In 1920, hog slaughter at interior plants in Iowa, Minnesota, the Dakotas, and Nebraska accounted for 39 per cent of total federally inspected slaughter in these states; whereas by 1945 this had increased to 67 per cent. Slaughter of other classes of meat animals has also increased in interior plants, although the shift has not been so marked. The major packers, located on the old established central markets, have countered this move through decentralization of their own operations, chiefly through direct buying and purchases of some of the interior plants.

Without doubt, the most important single factor contributing to the decentralization of meat packing was the development

and use of motor trucks, together with the extension of hard-surfaced roads. Other factors that have favored the development of interior plants are: improved market information, increased feed and livestock production in certain areas, saving in freight rates by marketing closer to home, and more favorable labor costs in certain areas.

METHODS OF MARKETING LIVESTOCK

The producer of livestock is confronted with the perplexing problem of determining where and how to market his animals. Usually there is a choice of outlets, and the one selected often varies with different species of livestock and among sections of the country. The methods of marketing also differ between slaughter and feeder animals, and all of these differ from the marketing of purebreds. Despite the advantages that any one of the methods of marketing may offer in a given transaction, the uninformed should not underestimate the value of central markets, for they are the firm foundation of the entire marketing system, providing a needed regulating and stabilizing influence. In the present trend toward more decentralization, this fact should be recognized for, after all, there is a limit to how small a central market may be and yet remain sufficiently strong to exert this regulating and stabilizing influence.

Local Buyers

Local buyers usually purchase for shipment to central markets. This is a highly speculative venture, requiring keen judgment and knowledge of markets and considerable courage on the part of the buyer. This method of marketing declined with the advent of improved highways and motor trucks and the growth of the cooperative marketing movement and direct buying.

Commission Firms

Commission firms on central markets serve as the owner's agent and make the sale. These firms really took over a part of the services originally performed by the drovers. According to early market records, the first livestock commission company in the United States opened for business on the Chicago Market in 1857. These firms or agencies, operating on public markets, sell livestock consigned to them by farmers, shipping associations, and dealers; and they buy stocker, feeder, and breeding stock on order for farmers and ranchers.

Cooperative Marketing

Cooperative marketing includes cooperative shipping associations and cooperative commission agencies.

The cooperative shipping association had its inception before the days of truck transportation and direct buying. The first cooperative shipping association of which there is authentic record was organized by a group of farmers at Superior, Nebraska, in 1883. The movement was really prompted as a means of circumventing the local buyer who, the producers thought, was not paying full value. In cooperative marketing, the producers in a given locality pool their livestock and ship cooperatively, usually consigning to cooperative commission agencies at the present time. In certain sections of the country, however, notably in Ohio and California, some of these local associations do direct selling to packers, therefore not passing their stock through either the cooperative selling agencies or the central market.

The cooperative commission agencies came about with the expansion of the cooperative movement and because the producers patronizing the local livestock shipping associations began to believe that they were not getting satisfactory service from the established old-line commission firms on the central markets. The cooperatives were designed to serve as selling agencies for shipping associations. But at the present time, much of the livestock sold by the cooperative agencies is consigned directly to them by producers without having passed through a local shipping association. The first cooperative commission agency was opened on the market at South St. Paul on August 8, 1921.

The cooperative livestock marketing movement has been stronger in certain areas than in others. Today, about 25 per cent of all commercial livestock sold annually in the United States is marketed cooperatively.

Community Livestock Auctions

The community livestock auction system is that method of selling in which the animals are sold to the highest bidder, either on a per head or weight basis. This method of selling livestock in this country is very old, apparently being copied from Great Britain where auction sales date back many centuries. United States livestock auctions, however, have had their greatest growth since about 1923, both in numbers established and in the extensiveness of the area over which they operate. Although

there is an area difference, in general, community livestock auctions handle slaughter animals, immature and unfinished animals destined for grazing or feeding, breeding animals, and horses and mules. Most of the auctions are owned and operated by an individual or partnership, although a few are cooperatively owned. Charges for selling animals are made on a per head or percentage basis. Sometimes small additional charges are made for yardage, health inspection, and insurance.

Some of the reasons for the rather marked growth in live stock auctions since 1923 are: (1) the need for satisfactory market outlets for small producers; (2) lack of local shipping associations; (3) the desire to sell near home; (4) the appeal that auction methods hold for producers, chiefly from the standpoint of seeing competitive bidding, observing comparative market values, and visiting with the neighbors. In addition auctions thrive when prices are low, because producers wish to market near home and at a minimum of out-of-pocket costs; and business men have encouraged local auctions as a means of attracting trade.

Some of the less desirable practices existing in certain community livestock auctions are: (1) Auction operators buy producers' livestock before the sale and sell in competition with livestock consigned by farmers and ranchers; (2) they bid and they sell slaughter animals on a per-head rather than on a per-pound basis; and (3) unless due care is exercised, auction yards may be a major factor in the spread of diseases and parasites, although in most states they are supervised by the respective state veterinarians. Prospective purchasers would do well to check carefully on the disease and parasite hazard before buying at community livestock auctions.

Direct Marketing

In direct marketing, slaughter animals are sold direct to meat packers either at the point, at concentration yards, or to buyers in the country. In other words, this method of selling short-cuts the central markets and commission firms, and the animals are bought directly by packer representatives. With stockers, feeders, and breeding stock, direct marketing also applies to transfer of ownership through sale other than at central markets. Increasing numbers of stocker and feeder cattle and feeder sheep have moved direct from range to feed lots and pastures in the Corn Belt states and elsewhere during recent years.

This method of buying slaughter animals was accelerated by he large nationwide packers following World War I in order to neet the increased buying competition of the small interior packers. The growth of interior packers was associated with the xpansion of corn and livestock production and livestock feeding n certain areas, such as the northwestern Corn Belt states. As reviously noted, improved highways and motor truck trans-

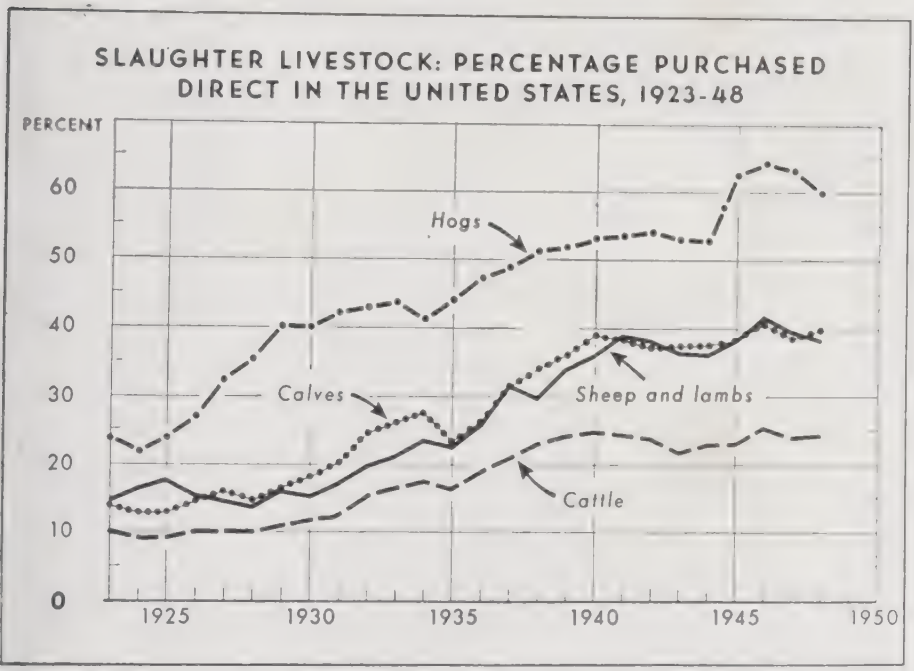


Fig. 87. Percentage of slaughter animals by classes, sold direct to meat ackers either at the plant, at concentration yards, or to buyers in the coun-y. Direct marketing increased following World War I. The growth of terior packing plants, and the coming of improved highways and increased otor truck transportation—factors favorable to decentralization—caused e nation-wide packers to accelerate their direct buying. (Courtesy, .S.D.A., Bureau of Agricultural Economics.)

ortation also favored the decentralization of markets. Thus rect buying was resorted to by the large meat packers as a eans of attempting to regain some of the animals, especially ogs, which were going to the independent plants. It was not a ew method of marketing, however, for during the days of ailing and drovers, long before central markets existed, animals ere sold to slaughterers by direct marketing. After all, public arkets and commission firms were not of importance until after e time of the Civil War.

Selling on Basis of Carcass Grade and Weight

To date, this method of selling has been confined chiefly to hogs. It is the most common method of marketing hogs in Denmark, Sweden, and Canada, but only limited selling on this basis has been followed in the United States. In brief, the bargaining is in terms of the price to be paid per hundred pounds dressed weight for carcasses that meet certain grade specifications. It is the most accurate and unassailable evaluation of the value of a carcass. From the standpoint of the packer, this procedure is more time consuming than the conventional basis of buying, and there is less flexibility in the operations.

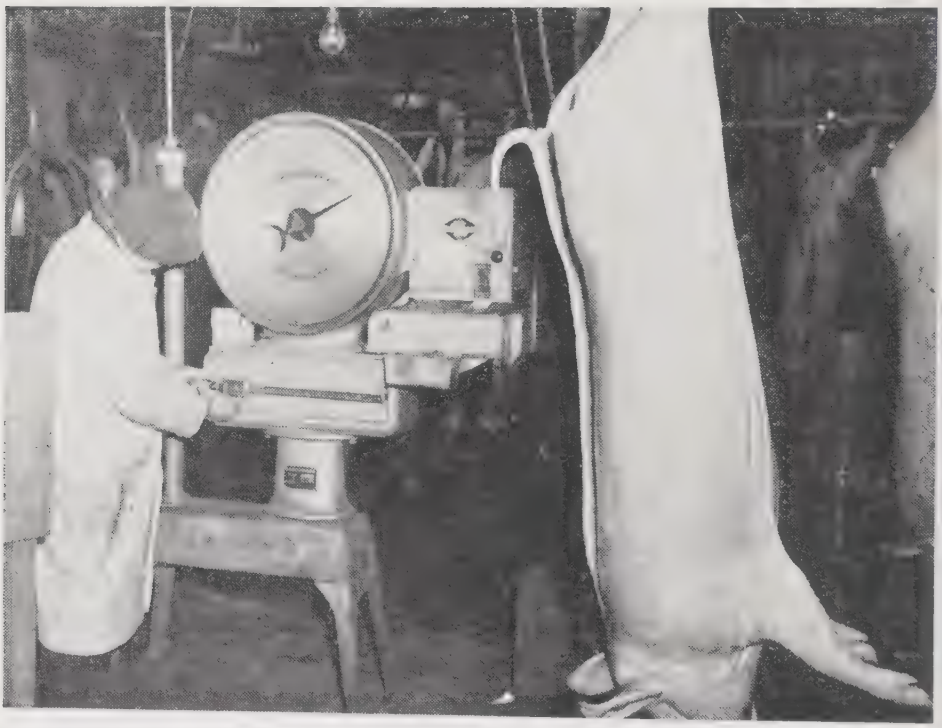


Fig. 88. Weighing Canadian hog carcasses. Selling on the basis of carcass grade and weight is the most common method of marketing hogs in Denmark, Sweden, and Canada. (Courtesy, Dept. of Agri., Ottawa, Canada.)

In general, farmers who produce superior animals benefit from selling on the basis of carcass grade and weight, whereas the producers of lower quality animals usually feel that this method unjustly discriminates against them. In countries where rail grading has been used extensively, there has been an unmistakable improvement in the breeding and feeding of swine. Denmark, Sweden, and Canada have effectively followed this

type of program in producing high quality bacon, chiefly for export to the London market.

The factors favorable to selling on the basis of carcass grade and weight may be summarized as follows:

1. It encourages the breeding and feeding of quality hogs.
2. It provides the most unassailable evaluation of the product.
3. It eliminates wasteful "filling" on the market.
4. It makes it possible to trace losses from condemnations, bruises, and soft pork to the producer responsible for them.
5. It is the most effective approach to animal improvement.

The factors unfavorable to selling on the basis of carcass grade and weight are:

1. The procedure is more time consuming than the conventional basis of buying.
2. From the standpoint of the meat packer, there is less flexibility in the operations.
3. The physical difficulty of handling the vast United States volume of hogs on this basis is great.
4. There is delay in returns to the shipper.
5. Decreased bargaining power exists on the part of the producer or his agent.
6. Grading in the presence of the buyer and absence of the seller, opens the way to fraud—suspected by the seller, if not proved.

Although the United States produces and processes many times the number of hogs slaughtered in countries where this system of marketing is prevalent, the proponents of carcass grading feel that the same benefits may be expected to accrue from the use of this method in this country. True enough, personnel must be trained and the system must be well planned and thoroughly understood prior to execution. Yet, the system has few of the faults of the present system of buying hogs chiefly on the basis of weight and dressing per cent. The latter system automatically favors the fat, lardy hogs, which animals have an unmistakably higher dressing percentage but which produce a surplus of lard. As is well known, lard has long remained a drug on the market except during the war years. There is need therefore, for a system of marketing which favors payment for a high cut-out value of primal cuts and a quality product. Selling on the basis of carcass grade and weight fulfills these needs.

Sale To Local Butchers Or Local Feeders

Local butchers or local feeders may purchase the livestock directly from farmers and ranchers. Many of the local butchers disappeared with the advent of the large meat processing companies, but in some of the more isolated areas the local slaughterers still buy and process a good many animals produced in the immediate area. Likewise, there are usually certain farmers or ranchers in most areas who have sufficient home-grown feeds to make it profitable for them to buy up a limited number of feeder animals in the immediate locality and to finish such animals for market. Sale of stock to local butchers and local feeders is really another form of direct marketing.

Home Slaughter

Home slaughter, which had its origin in colonial times, continues on farms to this day. This method of disposing of animals is relatively more important for hogs and calves than for other classes of livestock. It is least important for sheep and lambs. Present farm slaughter is largely done in order to provide meat for home consumption. On the other hand, during the winter months, the farmers in certain areas still sell fresh meats to consumers living in villages and towns or cure pork for sale at other seasons.

Selling Purebred Animals

Selling purebred animals is a highly specialized and scientific business. Purebred animals are usually sold at private treaty directly to other purebred breeders or commercial producers or through auctions which may either be sponsored by one or a few breeders (joint sales or consignment sales).

In general, the vast majority of males of all species saved for breeding purposes go into commercial herds and flocks. Only the elite sires are retained with the hope of affecting further breed improvement in purebred herds. On the other hand, the sale of purebred females is fairly well restricted to meeting the requirements for replacement purposes in existing purebred herds or for establishing new purebred herds.

Most consignment sales are sponsored by a breed association, either local, state-wide, or national in character. Such auctions, therefore, are usually limited to one breed. Purebred auction sales are conducted by highly specialized auctioneers. In addition to being good salesmen, such auctioneers must have a keen knowledge of values and be familiar with the blood lines of the breeding stock.



Fig. 89. A purebred bull sale at Toronto, Ontario, Canada, 1949. Note the ring and the bull in it, the auction stand, and the large crowd. Purebred auction sales are conducted by highly specialized auctioneers. (Photo by James E. Rose, Toronto, Canada.)

WHAT DETERMINES PRICES OF MARKET LIVESTOCK

The price that prevails for slaughter animals on foot is primarily determined by the amount which consumers are willing and able to pay for meat and animal by-products.

Because meat animals normally provide more than one-fourth of the entire cash income of United States farmers and ranchers, the importance of market prices is self-evident. But livestock raised for market are valuable only to the extent to which the meat and by-products obtainable from them are valuable.

The price of meats and animal by-products is largely determined by supply and demand, with the demand being affected primarily by buying power and competition from other products.

ESSENTIAL FACTORS OPERATING IN A CENTRAL MARKET

A modern central or terminal market is a very complex organization, and the larger it is the more complex it becomes. Among the more essential factors operating in each large central market are: (1) stockyards company, (2) commission companies or firms, (3) buyers, (4) livestock exchange, (5) traders live-

stock exchange, (6) banks, (7) market news services, and (8) federal and state agencies.

Stockyards Company

The stockyards company owns the land, yards, and equipment necessary for unloading, weighing, and handling of livestock while they are being marketed. Employees of this company unload, count, yard, and feed and water the animals as directed by the commission company to whom they are consigned. The stockyards company neither buys nor sells livestock. It derives its income from a yardage fee, the sale of feed and bedding, rental of office space, and, in some cases, rental of land to packers and others who have erected buildings on the stockyards property. Sometimes in connection with rail shipments, the network of tracks and locomotives used in the movement of cars in the yards and the work of "spotting cars" is a function of a separate stockyards transportation company, which charges for its services on a car basis. However, this phase of central markets sharply declined with the advent of truck transportation.

Commission Companies or Firms

The commission companies came into existence with the organization of central markets and the development of rail transportation. Their principal functions are to sell livestock consigned to them by farmers, shipping associations, and dealers and to buy stocker and feeder cattle, feeder lambs and pigs, and breeding animals of all species on order for farmers and ranchers. For rendering these services, they charge a commission on a per-head or per-carload basis; hence, the name "commission company." Both the old line commission companies and the cooperatives function in a similar manner.

The stockyards company allots blocks of pens to each commission company, basing such allotment upon volume of business performed. In these pens, the commission company salesman displays and sells the animals consigned to him. Although there is nothing to prevent farmers and ranchers from doing their own selling on the central market, it is generally recognized that this is a highly specialized field and that these services are best performed by a skillful, honest salesman who is blessed with sound judgment and who understands the intricacies of a large market. Following the sale of animals, the commission company promptly remits (usually the same day) to the consignor the amount received for animals sold, less deductions for

transportation charges, if any. The account of sales also includes complete information with respect to dead, docked or crippled animals, or those that were sold subject to inspection following slaughtering. The financial responsibility of commission companies is always assured through required bonding.

Buyers

It has often been said that "buyers make the market." Certainly, no market would continue to be patronized unless the consignors feel that the sales are as good or better than could be made elsewhere. The following types of buyers operate on the central markets.

PACKER BUYERS:

Packer buyers, who are employed by and purchase for packing plants, are the most important buyers at most public markets. These buyers may represent local or independent packers or the large organizations of national character.

ORDER BUYERS:

Order buyers are private individuals or partnerships operating on a market; they buy on order for distant packers and others and charge a commission for their services. Because orders are shifted by purchasers to markets where the prices are most favorable, order buyers exert considerable influence toward keeping the market upon which they operate in line with other markets.

YARD TRADERS:

Yard traders (also known as dealers, speculators, or scalpers) buy livestock, chiefly from commission companies, in the hope of making a profit from the subsequent sale. Most of their purchases consist of animals suitable for further feeding; they sort and regroup these animals before selling.

LOCAL BUTCHERS:

Local butchers generally search for small or odd lots of fat stock for slaughter purposes. Although individual purchases are usually small, the combined purchases of local butchers usually add up to make for a competitive situation on many markets.

Livestock Exchange

The livestock exchange is chiefly an organization of the commission companies operating on a public market. In addition, at some markets membership includes yard traders, packer buyers, and order buyers. The first livestock exchange was organized

on the Cincinnati market in April, 1881. Today, similar organizations exist on most of the important public markets. In addition, there is a national livestock exchange made up of membership from the local units.

The two major objectives of the livestock exchange are: to assure fair dealings between members of the exchange and to promote the interests of the market as a whole. Subject to the approval of the Secretary of Agriculture, they fix the schedule of charges for buying and selling livestock on the market in which they function. They also handle shipper's claims against carriers for losses in transit and excess charges, supervise the docking of stag hogs and pregnant sows, and cooperate with other agencies in attempting to reduce transit and yard losses from death, crippling, bruises, and contagious diseases. Most livestock exchanges also require that the members post satisfactory bonds to insure financial responsibility.

Traders Livestock Exchange

On some public markets, the yard traders are organized into a traders' livestock exchange. This is a separate and distinct organization from the livestock exchange, but it serves its membership and functions in a similar manner. Its chief objectives are to insure fair dealings between members and fair trade practices between the members and those with whom they deal. Members pay dues and post bonds in order to guarantee financial responsibility.

Banks

The first bank located at a central market and primarily founded to serve market interests was organized at Chicago in 1868. Today, one or more banks are to be found at most of the leading public markets. Such convenient banking facilities make it possible for the buyer to arrange for prompt payment and for the commission companies to remit proceeds to consignors with the least possible delay. In addition to serving the needs of market interests, the banks operating on central markets make loans to both breeders and feeders of cattle and sheep.

Market News Services

Accurate market news is essential to the efficient marketing of livestock, both from the standpoint of the buyer and the seller. In the days of trailing, the meager market reports available were largely conveyed by word of mouth. Moreover, the time

required to move livestock from the farm or ranch to market was so great that detailed market information would have been of little benefit even if it had been available. With the speed in transportation afforded by railroads and trucks, late information on market conditions became important.

THE CORN BELT FARM DAILIES:

The Corn Belt farm dailies consist of four publications: *The Chicago Daily Drovers Journal, Omaha Daily Journal-Stockman, Kansas City Daily Drovers Telegram*, and *The St. Louis Daily Livestock Reporter*. The Chicago publication, which is the largest of the daily livestock papers, was founded in 1873, first operated as a weekly. These publications are highly respected by both buyers and sellers, and the editorials therein are followed closely by stockmen. Their market quotations are accepted as "official," and, as such, are received without prejudice in all courts of equity. Since 1901, the *Chicago Daily Drovers Journal* has issued the *Drovers' Journal Yearbook of Figures*, an annual publication devoted primarily to summarizing statistics of the livestock trade.

THE FEDERAL MARKET NEWS SERVICE:

The Federal Market News Service was initiated by the U. S. Department of Agriculture, beginning in 1916. This service was established for the purpose of providing unbiased and uniformly interpretable market information. At the present time, thirty-four different livestock markets are covered by the Federal Market News Service. This network of branch offices is connected by a system of leased telegraph wires so that the central office in Washington. D. C., as well as each of the thirty-four branches, receive several reports daily from every other office. Practically all of the branch offices collect and report livestock information, but only a few cover meat and wool. Nevertheless, livestock, meats, and wool statistics are included in the service. The market information is assembled and widely disseminated through the medium of (1) newspapers, (2) the radio, and (3) a considerable number of daily, weekly, monthly, and annual reports distributed directly by the Federal Market News Service. The Federal Market News Service relies upon local and privately owned newspapers and radios, merely supplying them with the market reports. Because at least a part of the readers or listeners are interested in this type of information, the local papers are usually glad to serve as a medium for disseminating these reports.

The chief contributions of the Federal Market News Service may be summarized as follows: (1) A common terminology has come to be established from market to market, thus a slaughter steer which will grade "good" at Chicago would be designated the same grade at every other market in the country; and (2) more adequate facilities for the dissemination of market information have been provided.

MARKET INFORMATION SUPPLIED BY COMMISSION COMPANIES:

Cards or circulars are issued by some commission companies as a convenient means of keeping their patrons informed on market conditions and also as a means of soliciting shipments.

Federal and State Agencies

With the growth of the far-flung livestock marketing system and meat slaughtering, processing, and distribution, it soon became apparent that federal and state supervision was necessary to prevent unfair and discriminatory trade practices, to protect the public health, to insure humane methods of handling animals, and to establish fair and equitable rates and charges for all agencies operating on a given public market. The various services rendered, legislative acts, and state and federal organizations carrying out these functions will be discussed briefly.

FEDERAL MEAT INSPECTION:

The federal government requires supervision of establishments which slaughter, pack, render, and prepare meats and meat products for interstate shipment or foreign exports; whereas it is the responsibility of the respective states to have and enforce legislation governing the slaughtering, packaging, and handling of meats shipped intra-state. The meat inspection laws do not apply to farm slaughter for home consumption, although most states require inspection if the meat is sold or transported away from the farm.

The meat inspection service of the U. S. Department of Agriculture was inaugurated and is maintained by the *Meat Inspection Act of June 30, 1906*. Until February 9, 1943, the assignment for carrying out the provisions of this act was charged to the Meat Inspection Division of the Bureau of Animal Industry (B.A.I.), but at that time it was transferred to the Food Distribution Division for the duration of World War II. The purposes of this act are: (1) To safeguard the public by eliminating diseased or otherwise unwholesome meat from the food supply; (2)

to enforce the sanitary preparation of meat and meat products; (3) to guard against the use of harmful ingredients; and (4) to prevent the use of false or misleading names or statements on labels. Personnel for carrying out the provisions of the act are of two types: professional or veterinary inspectors who are graduates of accredited veterinary colleges and non-professional



Fig. 90. Ante-mortem (before death) inspection of a carlot of cattle being made by a federal veterinarian. Animals that are clearly diseased, emaciated, or otherwise unfit for human food are destroyed. Their carcasses may be used only in making inedible grease, fertilizers, or other non-food products. Animals that appear slightly abnormal on foot are tagged "U. S. Suspect," and are given special post-mortem scrutiny. (Courtesy, U.S.D.A.)

or lay inspectors who are required to pass a Civil Service examination. In brief, the inspections consist of the following two types:

1. **Ante-Mortem (before death)** inspection is made in the pens or as the animals move from the scales after weighing. The inspection is performed to detect evidence of disease or any abnormal condition that would indicate a disease. Suspects are provided with a metal ear tag bearing the notation "U. S. Suspect No. ____", and are given special post-mortem scrutiny. If in the ante-mortem examination there is definite and conclusive evidence that the animal is not fit for human consumption, it is

"condemned," and no further post-mortem examination is necessary.

2. **Post-Mortem (after death)** inspection is made at the time of slaughter and includes a careful examination of the carcass and the viscera (internal organs). All good carcasses are stamped "U. S. Inspected and Passed," whereas the inedible carcasses are stamped "U. S. Inspected and Condemned." The latter are sent to the rendering tanks, the products of which are not used for human food.



Fig. 91. Post-mortem (after death) inspection of the viscera (internal organs). The carcass is also carefully examined. All good carcasses are stamped "U. S. Inspected and Passed," whereas the inedible carcasses are stamped "U. S. Inspected and Condemned." The latter are sent to the rendering tanks, the products of which cannot be used for human food. (Courtesy, U.S.D.A.)

In addition to the ante-mortem and post-mortem inspections referred to, the government meat inspectors have the power to close a plant that is not sanitary in every respect. The floors and tables in the plant must be washed every day; tools must be thoroughly sterilized; and workmen must have clean garments and adequate lavatory facilities for keeping their person clean.

Meat inspection regulations condemn the carcasses of animals suffering from anthrax, peritonitis, enteritis, uremia, septicaemia, pleurisy, parturient paresis, tetanus, extreme emaciation, pseudotuberculosis, generalized tuberculosis, and shipping fever.

Other ailments that are given careful scrutiny but which may or may not render a carcass unfit for food, depending upon

the stage of the disorder, are: lumpy jaw, tuberculosis, tumors, and advanced pregnancy.

During the prewar period, 1935-39, 66 per cent of the total meats were produced in federally inspected plants. During the war years, a higher proportion of meat slaughter came under federal inspection, reaching a peak of 71 per cent in 1944. At the close of hostilities, however, the proportion of total meat produced under federal inspection declined to 67 per cent in 1945 and 60 per cent in 1946, but the trend is again upward, 69.3 per

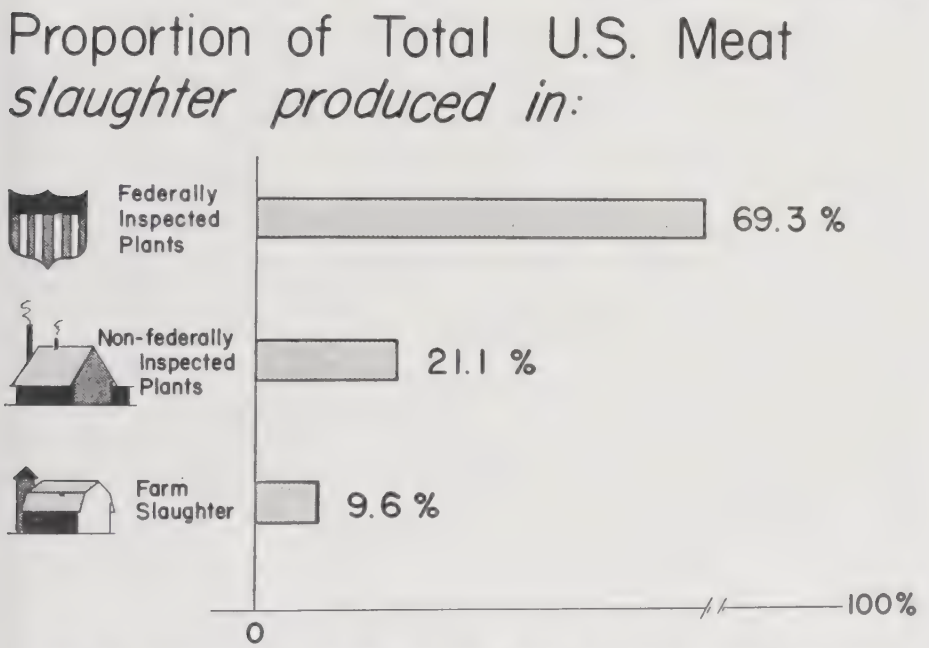


Fig. 92. Proportion of total United States meat slaughter produced in (1) federally inspected plants, (2) non-federally inspected plants, and (3) farm slaughter, 1947. (From U.S.D.A. data. Drawing by R. F. Johnson.)

cent of all meats having been federally inspected in 1947. The 1945 to 1946 decline in federal inspection is attributed to the selling of meat via the black market during this period, thus circumventing price controls and rationing. At the beginning of 1945, there were 477 establishments (not companies) conducting slaughter under federal inspection. This represented only 15 to 20 per cent of all commercial meat packers. But these establishments average much larger in size than the nonfederally inspected ones, thus making it possible for them to account for the major portion of total United States slaughter.

Figure 92 shows the proportion of the total United States meat slaughter that was produced in (1) federally inspected

plants, (2) nonfederally inspected plants, and (3) farm slaughter in 1947.

STATE MEAT INSPECTION:

Different states have varying legislation governing the slaughter, packaging, and handling of meats shipped intrastate. Local slaughter houses also are often supervised by community or city ordinances. Usually, state permits are issued to plants operating in a state, and inspection is administered by the state department of agriculture.

PACKERS AND STOCKYARDS ACT OF 1921:

On August 15, 1921, Congress passed the *Packers and Stockyards Act* which gives the Secretary of Agriculture supervision of packers and all others engaged in business at public stockyards. This law was enacted in order to prevent packers from engaging in unfair, discriminatory, or deceptive practices tending to restrain trade or create a monopoly or from indulging in practices having the effect of manipulating or controlling prices. The law also decrees that all rates charged by stockyards companies and market agencies shall be just, reasonable, and nondiscriminatory. Until 1938, the Packers and Stockyards Act was administered by the Bureau of Animal Industry, but on October of that year responsibility was shifted to the Agricultural Marketing Service of the U. S. Department of Agriculture. Fines are levied as penalties for violations, but the accused has the recourse of courts, which must uphold any ruling of the Secretary of Agriculture before the action is considered final.

THE TWENTY-EIGHT HOUR LAW REGULATING TRANSPORTATION OF LIVESTOCK:

In 1873, Congress passed a law making it prohibitive for any carrier to transport livestock by rail for a longer period than twenty-eight consecutive hours without unloading for the purpose of giving feed, water, and rest for a period of at least five consecutive hours before resuming the transportation. The period may be extended to thirty-six hours upon written request from the owner of the animals or his agent. With less than carload lots (L.C.L. shipments), the owner may provide feed and water in the car with instructions that the animals be fed and watered enroute.

The purpose of the twenty-eight-hour law was to prevent cruelty incident to the shipment of livestock. Prior to enactment of this legislation, it was not uncommon for carriers to confine

animals to cars without feed and water for periods of fifty to sixty hours or even longer.

At the present time, no such law applies to the truck transportation of animals.

HEALTH-CONTROL OFFICIALS:

At every large central market, two groups of health-control officials are represented: the Bureau of Animal Industry of the U. S. Department of Agriculture and regulatory officials of the state department of agriculture. These health-control officials are vested with the responsibility of preventing the spread of animal diseases. The federal government (through the B.A.I.) has jurisdiction over interstate shipments, and the laws governing such movement apply uniformly to all parts of the country. The several states have separate and different laws governing the inshipment of livestock from other states and the control of livestock diseases within the state.

Although the act has been considerably modified and extended, the first federal legislation designed to control the spread of animal diseases was passed in 1884. State regulations have concerned themselves primarily with the eradication of tuberculosis, hog cholera, and Bang's disease. Because of lack of uniformity in state laws, there has been considerable controversy in the regulations governing the control of the latter disease, particularly when calfhood vaccination is involved.

BRAND INSPECTION:

Brand inspection of western cattle is undertaken primarily to prevent the stealing (rustling) of animals on the range and their subsequent shipment and sale to innocent parties at the big markets. This service is also very useful in recovering stray animals that have become mixed in with other cattle and cattle that, through oversight, have been shipped to market by parties other than the real owners. Brand inspection is supported by and under the supervision of the different stock growers' associations of the range states. In Montana, however, the state government manages the work. Brand inspection is taken care of by men expert in the reading and deciphering of brands. They examine each individual in every shipment of branded cattle.

Summary of Central Marketing Procedure of Slaughter Animals

Briefly, the steps through which slaughter animals usually pass from the farm or ranch to and through the central market and on to their final destination are as follows:

1. Animals are transported to the central market by truck or rail, with the former method most commonly used for short hauls and the latter for greater distances. When rail shipments are used, federal supervisors check for the compliance with the twenty-eight-hour law, requiring that animals in transit for more than twenty-eight hours be fed, watered, and rested for five hours before resuming transportation.

2. Representatives of the stockyard company receive, unload, count, yard the animals in pens assigned to the commission company to which the shipment is consigned, and feed and water the animals as directed by the commission company.

3. The salesman for the commission company makes the best sale possible to a packer buyer, order buyer, yard trader, or local butcher.

4. The stockyards company then weighs, counts, records, and delivers or reships the animals to their final destination.

5. Following the sale of the animals, the commission company promptly remits to the consignor the net proceeds, deducting transportation charges, yardage, feed, commission, insurance, etc. The proper commission is retained by the commission company; and it assumes full responsibility for payment of the other bills for which deductions are made from the proceeds.

6. At the larger market one or more conveniently located banks facilitate prompt payment by the buyer and the earliest possible remittance to the consignor by the commission company.

7. The livestock exchange and traders' livestock exchange, which exist on most of the larger markets, insure fair dealings and integrity on the part of their members and require that they post bond as a guarantee of financial responsibility.

8. Federal meat inspectors, functioning under the Meat Inspection Act of 1906, make ante-mortem and post-mortem inspections of all slaughter animals. They also enforce sanitary regulations covering both the yards and packing plants. In intrastate yards and plants, a less complete service is rendered by the respective state department of agriculture.

9. Federal officials, operating under the provisions of the Packers and Stockyards Act, ascertain that fair and competitive practices are observed by the packers and commission companies and that reasonable charges are made for marketing services rendered.

10. Health-control officials, both state and federal, enforce such practices as will prevent the spread of contagious diseases. They supervise especially shipments of stocker, feeder, and

breeding animals back to the farm or ranch or the reshipment of fat animals to another market.

11. In marketing western cattle, brand inspectors maintain a constant vigilance for stolen or stray animals.

12. The various market news services including Federal Market News Service (operating through the medium of newspapers, radio broadcasts, and their own federal publications), the Corn Belt dailies, and market information supplied by commission men keep both buyers and sellers well informed regarding supplies and prices.

SHRINKAGE IN ANIMALS

The shrinkage (or drift) generally refers to the weight loss encountered from the time the animals leave the feed lot until they are weighed over the scales at the market. Thus, if a steer weighed 1,000 pounds at the feed lot and had a market weight of 970 pounds, the shrinkage would be 30 pounds or 3.0 per cent. Shrink is usually expressed in terms of percentage. Most of this weight loss is *excretory shrink*, or in the form of feces and urine, and the moisture in the expired air. On the other hand, there is some *tissue shrinkage*, which results from metabolic or breaking-down changes.

Shrinkage is of importance because the carcass meat is the most valuable portion of the animal. For this reason, dressed yield is one of the most important factors taken into consideration by packers in buying livestock for slaughter.

Factors Affecting Shrinkage in Animals

The most important factors affecting shrinkage are: (1) the fill; (2) time in transit; (3) truck versus rail transportation; (4) season; (5) age and weight; and (6) overloading, rough ride, abnormal feeding, and mixed loads.

EFFECT OF FILL ON SHRINKAGE:

The fill refers to the amount of feed and water consumed by animals upon their arrival at the market and prior to selling. Normally, the fill of hogs consists of a feed of some grain (small grains are ground) common to the area and water; whereas the fill of cattle and sheep consists of hay and water, although grain-fed animals may be given some concentrate. Naturally, the larger fill animals take, the smaller the shrinkage.

There are both advantages and disadvantages to the practice of feeding and watering animals prior to offering them for sale, with the proponents of each system advancing very convincing

arguments. Some men claim that the fill has a quieting effect on the animals, that it corrects the gaunt appearance following shipment, and that it adds weight. On the other hand, others point out that to fill animals immediately prior to offering them for sale does not add to the weight of the carcass and that it is a wasteful practice.

Experienced buyers take the amount of fill into consideration when arriving at their offering price. In other words, dressing percentage is a major factor in determining values, and experienced buyers are very deft in estimating carcass yield and degree of fill. As further evidence that packers object to excess fill, it is a well-known fact that when the weather is warm and animals have "tanked up" on considerable water, packer buyers make it a point to delay their purchases as late in the morning as possible, thus allowing for some elimination of excreta.

Because animals transported via motor truck may not have remained off feed too long, there is an increasing tendency not to feed and water them prior to selling on the market. This saving in feed and expense seems to be economically sound.

EFFECT OF TIME IN TRANSIT ON SHRINKAGE:

The longer animals are in transit, the greater the shrinkage. Shipping distance is also a factor, though not so important as time in transit.

EFFECT OF TRUCK VERSUS RAIL TRANSPORTATION ON SHRINKAGE:

Earlier experimental studies showed slightly lower shrinkage on animals shipped by rail than when transported by motor truck. It must be remembered, however, that during recent years motor trucks have been greatly improved from the standpoint of longer wheel base, easier riding, and greater speed. This, together with improved highways, has reduced considerably the jostling of livestock in truck transit. These factors, plus the greater speed and flexibility of truck transportation on shorter hauls, would lead one to assume that for the distances for which they are adapted, truck shipments may now actually cause less shrinkage than rail shipments. Naturally, truck shipments are poorly adapted to long hauls, among other things, because of the difficulty of unloading for purposes of feeding and watering enroute.

EFFECT OF SEASON ON SHRINKAGE:

Extremes in temperature, either very hot or very cold weather, result in higher shrinkage. In general, however, animals

in transit undergo more discomfort from higher summer temperatures than from those in other seasons of the year. Furthermore, the feeds consumed during the summer months contain a higher proportion of succulent feeds (such as pastures) which are conducive to higher shrinkage.

EFFECT OF AGE AND WEIGHT OF ANIMALS ON SHRINKAGE:

Although conclusive evidence is lacking, it is reasonable to expect that young animals of all species shrink more than older animals—because of the normally lower carcass yield of younger animals caused by less body fat and greater amount of fill in proportion to live weight. In general, experienced market men seem to be fairly well agreed on this assumption.

MISCELLANEOUS FACTORS AFFECTING SHRINKAGE:

In addition to the factors already enumerated, experienced stockmen indicate that the following conditions will increase shrinkage: (1) overloading or a rough ride, with frequent starts and stops enroute; (2) abnormal feeding immediately prior to shipment; and (3) mixed loads in comparison with straight loads, especially when the animals are not accustomed to being near other species (even though they are partitioned off in the car or truck). There is also indication that grain-fattened animals shrink less in shipment than animals that have been fed chiefly on roughage, but this may actually be due to their greater degree of fatness rather than to the kind of feed consumed prior to shipment.

BRUISES, CRIPPLING, AND DEATH LOSSES

Losses from bruising, crippling, and death that occur during the marketing process represent a part of the cost of marketing livestock; and, indirectly, the producer foots most of the bill.

Most bruises are caused by horned cattle; by projections in feed lots, motor trucks, cars, and stockyards; by failure to partition off properly different kinds and classes of livestock in cars or trucks; by overloading or underloading; and by rough and careless handling. A careful analysis of the cause of bruises indicates that most of this loss could be prevented. Unfortunately, unless cuts or bumps are present, most bruises cannot be detected until after the animals have been slaughtered. This being true and because market animals are purchased on the basis of live weight in the United States, slaughter buyers take the probable loss into consideration at the time of purchase. This procedure

is entirely justified because bruises render the particular spot unfit for human food. The National Livestock Loss Prevention Board is authority for the statement that the losses from bruises trimmed out in the United States slaughter plants during the year 1947 totaled an additional $6,000,000; or there is an annual



Fig. 93. Lamb carcass bruised from lifting by the wool. Total losses from bruises trimmed out in U. S. slaughter plants in 1947 cost an estimated $6,000,000 and, indirectly, the producer footed most of the bill. (Courtesy, National Livestock Loss Prevention Board.)

total loss of a $25,000,000 accruing from bruises, crippling, and death losses in marketing animals. The same factors that are responsible for bruising are also responsible for much of the loss from death and crippling. The following observations have been made relative to crippling and death losses:

1. Crippling in hogs is more common than in other species; the incidence of crippling in calves, cattle, and sheep ranks after hogs in the order named.



Fig. 94. Badly crippled hogs unable to walk into pens unassisted on arrival at market. Such animals are hauled in the "cripple cart," and are generally bought subject to inspection. The National Livestock Loss Prevention Board is authority for the statement that there is an annual loss of $25,000,000 accruing from bruises, crippling, and death losses in marketing animals. (Courtesy, National Livestock Loss Prevention Board.)

2. Death losses in calves are higher than is encountered in any other kind or class of livestock. From the standpoint of species, sheep have the highest death loss in marketing, followed by hogs, and cattle.

3. In-transit losses from crippling and death are higher among thin, emaciated, or overfat animals than among animals in a strong, vigorous condition.

4. Extreme heat or cold, or sudden temperature changes, lead to increased crippling and death losses.

5. The nutrition of the animals during the growing-fattening period is a major factor.

Although the connotation of the word "crippled" varies somewhat from market to market, usually an animal that arrives in such condition that it cannot walk into pens unassisted is recorded as a cripple. Badly crippled animals are generally bought subject to inspection. Dead animals are sent to the rendering tanks.

Precautions for Preventing Bruises, Crippling, and Death Losses

The following twenty-two precautions are suggested by the National Livestock Loss Prevention Board as a means of reducing market losses from bruises, crippling, and death:[1]

[1]Editorial, Chicago Daily Drovers Journal, July 12, 1948.

1. Dehorn cattle, preferably when young.

2. Remove projecting nails, splinters, and broken boards in feed racks and fences.

3. Keep feed lots free from old machinery, trash, and any obstacles that may bruise.

4. Do not feed grain heavily just prior to loading.

5. Use good loading chutes, not too steep.

6. Bed with sand free from stones, to prevent slipping.

7. Cover sand with straw in cold weather, but use no straw for hogs in hot weather.

8. Wet the sand bedding in summer before loading hogs and while enroute. Drench when necessary.

9. Partition all packing sows from light-weight butchers.

10. Provide covers for trucks to protect from sun in summer and cold in winter.

11. Always partition mixed loads into separate classes, and partition calves from cattle.

12. Have upper deck of truck high enough to prevent back bruises on calves below.

13. Remove protruding nails, bolts, or any sharp objects in truck or car.

14. Load slowly to prevent crowding against sharp corners and to avoid excitement. Do not overload.

15. Use canvas slappers instead of clubs or canes.

16. Tie all bulls in truck or car, and partition boars, stags, and cripples.

17. Bull board should be in position and secure before car door is closed on loaded cattle.

18. Drive carefully. Slow down on sharp turns and avoid sudden stops.

19. Inspect load enroute to prevent trampling of animals that may be down.

20. Back truck slowly and squarely against unloading dock.

21. Unload slowly. Do not drop animals from upper to lower deck; use cleated inclines.

22. Never lift sheep by the wool.

All of these precautions are simple to apply; yet all are violated every day of the year.

DEVELOPMENT OF MARKET CLASSES AND GRADES OF LIVESTOCK

With the turn of the century, the importance of having some uniform system of marketing livestock according to their rela-

tive merits or values was clearly recognized. Sensing this need, investigators of the Illinois Agricultural Experiment Station made a careful study of markets and published their findings and recommendations relative to market classes and grades in three different bulletins which appeared successively between 1902 and 1908.[1]

The need for uniform nationwide standards also soon became evident. Thus, in 1916, the U. S. Department of Agriculture was authorized to report market conditions and transactions at the various livestock markets in the United States. Using the earlier publications of the University of Illinois as a basis—and with the help of market specialists, representatives of producer organizations, and Land Grant Colleges—the U. S. Department of Agriculture undertook to define tentative standards for uniform market classes and grades of cattle, sheep, and hogs. Through the years, these standards have been further refined, and more and more people have come to interpret them in a like manner regardless of the market or section of the country.

In addition to being rather specific and uniform—for example, so that a choice light-weight, yearling, slaughter steer would be so designated on the several markets throughout the United States—it was recognized that the terminology must be easily understood and reasonably permanent in order to be workable. Moreover, the terminology must serve the market needs of producers, selling agencies, and buyers.

Use Made of Market Classes and Grades

Standard market classes and grades of animals have demonstrated their practicality in a number of ways. They have been especially valuable in rendering the following services:

1. In providing a means of selling animals according to their values.

2. As the standard vocabulary in market reporting, thus making possible more accurate and useful market reports.

3. As a guide to producers in shaping their breeding and feeding operations to meet market demands.

4. As a standard to insure fair dealing when animals are purchased on order.

[1]H. W. Mumford, *Market Classes and Grades of Cattle*, Illinois Agri. Expt. Sta. Bull. No. 78, 1902; William Dietrich, *Market Classes and Grades of Swine*, Illinois Agri. Expt. Sta. Bull. No. 97, 1904; and W. C. Coffey, *Market Classes and Grades of Sheep*, Illinois Agri. Expt. Sta. Bull. No. 129, 1908.

5. As a means of keeping various markets fairly well in line with each other.

6. As a means of insuring that direct buying prices are on an equitable basis to those prevailing at the central markets.

7. In providing a producer with a method of selecting the market in which he may secure the best returns. (The producer may review market reports based on standard classes and grades and with the flexibility of modern truck transportation, take advantage of the best market).

8. In providing a basis for compiling important statistical data used in analytical studies of supplies, demands, prices, and movements of livestock.

Definition of Market Classes and Grades

Grading livestock is the act of sorting, dividing, or designating animals of similar classes and grades. When grading is properly and expertly done, each individual of a specific class and grade group is quite similar to other individuals in that group, regardless of whether the animals are in the same pen or in separate markets hundreds of miles removed from each other.

Broadly speaking, *the market class is the use to which animals are put,* whereas *the market grade is a measure of how well the animal fulfills the requirements for the class.* More accurately, however, the market class is determined by all of those factors affecting the use and value of the animal, except the final grade. Thus in cattle, the market class is determined by whether the animals are cattle or calves; by the general use to which the animals are put (slaughter cattle, stocker and feeder cattle, milkers and springers, vealers, slaughter calves, and stocker and feeder calves); by the sex (steers, heifers, cows, bulls, or stags); by the age (yearling or two-year-old or over steers), and by weight.

The grade is the final subdivision in the classification process. It indicates the relative degree of excellence of an animal or group of animals.

Factors Determining Market Grades

In cattle, sheep, and hogs, the grade is determined by the following three factors, singly and in combination:

1. **Conformation.**—Conformation is the form, shape, outline, or contour of the animal. Superior conformation makes for a high dressing percentage, the maximum cut-out value of the

primal cuts, and the most desirable relationship between the lean, fat, and bone of the carcass. Breeding is chiefly responsible for variations in conformation, although the sex and the quality and distribution of fat also affect the build of an animal.

Though requiring experience to appraise, the conformation of a stocker or feeder animal indicates the shape the animal will have when it is finished.

2. **Finish.**—Finish refers to the degree of fatness of an animal, including the quality and distribution of the fat. For the most part, finish is determined by the amount and kind of feed consumed, although breeding, age, and sex are also factors. Finish is important in slaughter animals because it affects the palatability and nutritive qualities of the product, the dressing percentage, and the attractiveness of meats.

In stocker and feeder animals, the degree of fatness is usually referred to as condition rather than finish. Because finish —one of the three major factors determining grade—is lacking in feeder animals, the top grade in feeders is referred to as "fancy" instead of "prime."

3. **Quality.**—Quality is a more intangible sort of thing, but nonetheless important. In a slaughter animal, quality is denoted by breeding, refinement, degree of finish, and to some extent by age and sex. The quality of a feeder animal is indicated primarily by its breeding and refinement.

It is noteworthy that these three factors—conformation, finish, and quality—determine the carcass grade following slaughter. Further, live animal grades are based on projected carcass grades.

The market classes and grades of cattle, sheep, and hogs will receive further treatment in the section devoted to each of these species.

FACTORS WHICH INFLUENCE MARKET PRICES

Contrary to the opinion held by some, packers do not control livestock and meat prices. Rather, like most commodities, they are dominated chiefly by supply-and-demand forces. That is, fluctuations in livestock prices are due either to changes in the demand for meat or to changes in the supply of slaughter animals. The amount of meat that people will buy is affected by a wide variety of circumstances, such as industrial conditions and buying power, the competition of other foods in season, holidays, and weather. On the other hand, the number of animals available for

slaughter and the meat supply is largely determined by whether the animals return a profit or incur a loss to the producer, and by the extent of each.

Studies do reveal that livestock prices change in keeping with a somewhat regular pattern according to period of time. These types of price changes are: (1) long-time trends, (2) cyclical changes, (3) seasonal changes, and (4) short-time changes. Jewish holidays may also influence market prices, especially in eastern United States.

Long-time (or Secular) Trends

Long-time price trends are those which operate so slowly that they may not be detected for a number of years, perhaps for a period of fifty years or more. They are caused by such factors as changes in the standard of living or earning power of the masses of people in a country, by major population increases or decreases, or by long-time changes in production costs. The long-time price trends of cattle, sheep, and hogs have been very similar. In general, prices tended downward from the close of the Civil War to about 1896, after which price trends started upward. With the replacement of draft horses and mules by mechanical power, there has been a steady decrease in the demand for work animals accompanied by a long-time decrease in horse and mule prices. Aside from the recent wartime experience, the increase in numbers of meat animals has not kept pace with the increase of human population.

Cyclical Trends

The price cycle as it applies to livestock may be defined as that period of time during which the price for a certain kind of livestock advances from a low point to a high point and then declines to a low point again. In reality, it is a change in animal numbers that represents the stockman's response to prices. Although there is considerable variation in the length of the cycle within any given class of stock, over a long period of time it has been observed that the price cycle of the different classes of animals is about as follows: hogs, five years; sheep, ten years; and cattle, fifteen years.

The specie cycles of five, ten, and fifteen years, respectively, are a direct reflection of the rapidity with which the numbers of each class of farm animals can be shifted under practical conditions to meet consumer meat demands. Litter-bearing and early-producing swine can be increased in numbers much more rapidly than either sheep or cattle. When market hog prices

are favorable, established swine enterprises are expanded, and new herds are founded, so that about every five years on the average the market is glutted and prices fall, only to rise again because too few hogs are being produced to take care of the demand for meats. Normal cycles are disturbed by droughts, wars, general periods of depression or inflation, and federal controls.

Cyclic Trends

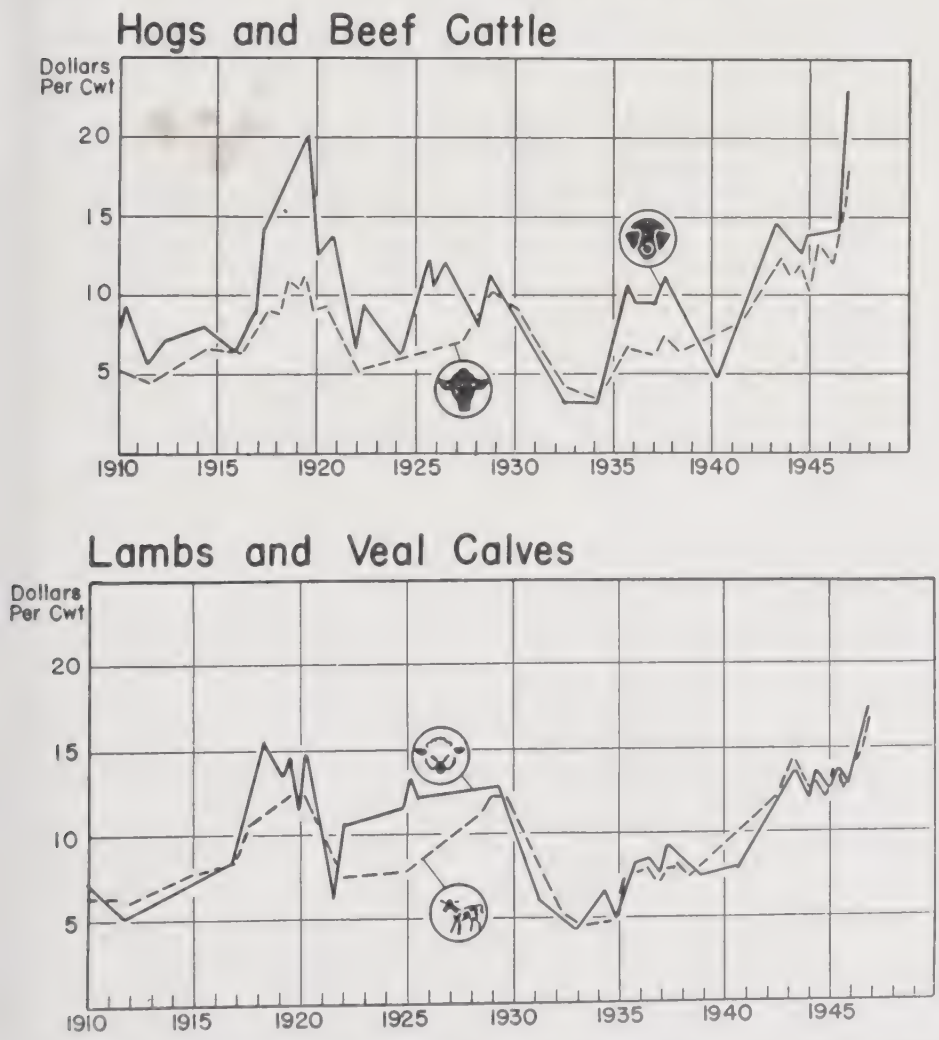


Fig. 95. Average price received by U. S. farmers for each class of livestock, 1910-1946. In general, this shows that the price cycle of each class of animals is approximately as follows: hogs, five years; sheep, ten years; and cattle, fifteen years. (Based on data obtained from U.S.D.A. Drawing by R. F. Johnson.)

Seasonal Changes

Livestock prices tend to vary seasonally, largely because of the seasonal production and seasonal marketing of animals. Thus seasons of large marketings are usually associated with relatively low prices and seasons of light marketings with relatively high prices. As would be expected, seasonal variations in prices vary with different species of livestock. For example, spring-born pigs (March, April, and May farrow) usually make for a large market volume and lower prices from October to January. The fall-farrowed pigs also exert a seasonal influence, although the numbers are smaller and the effect is less marked.

Grass-fat cattle are marketed in large numbers during the fall of the year at the close of the grazing season. On the other

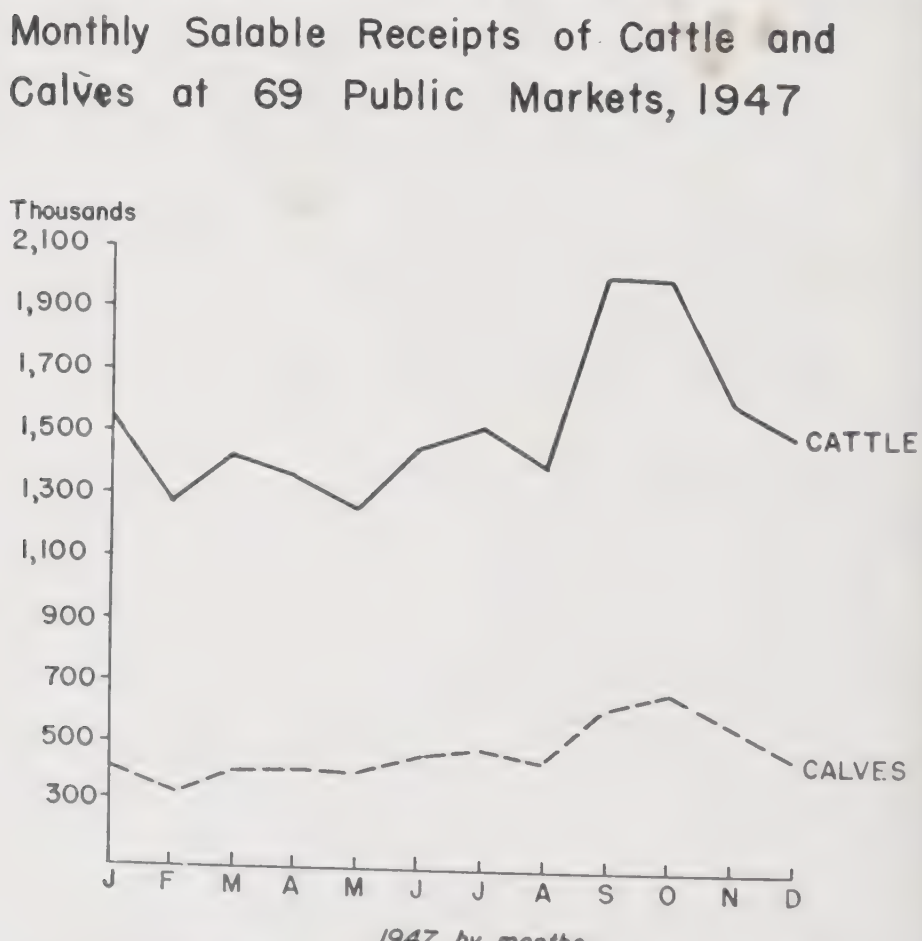


Fig. 96. Livestock prices tend to vary seasonally, largely because of seasonal marketing. This figure shows that the largest market receipts of both cattle and calves occurs in September and October at the close of the pasture season. (Data from Livestock Market News, U.S.D.A., July, 1948, pp. 17-18. Drawing by R. F. Johnson.)

hand, the greatest numbers of grain-finished steers are marketed in the spring of the year following the usual winter-feeding operations. Figure 96 shows the monthly salable receipts of cattle and calves at sixty-nine public markets in 1947. Spring-born lambs are marketed in greatest numbers in the fall of the year, which period usually coincides with seasonally low prices. In summary, the seasonal influences affecting different classes of farm animals are as follows:

Kind and class of animal	Low season in price	High season in price
Grain-fed steers	June	September
Stocker and feeder cattle (and grass-fat cattle)	Fall (December)	Spring and early summer (May)
Hogs	December and January	March, August, and September
Lambs	October	June

The progressive producer is well aware of these seasonal influences, and plans his production and market operations accordingly.

Short-time Changes

Day-to-day variations in livestock prices usually are caused by uneven distribution of receipts on a given market because of such factors as weather, interference with transportation, strikes, uncertain or threatened federal policies, and stock market fluctuations. Although such changes are not large, the shrewd producer and market specialist is quick to take advantage of fluctuations that are in his financial interest.

Jewish Holidays

The Jewish abstinence from eating meat during certain holidays exerts a minor influence on livestock prices. The important thing is that no kosher slaughtering is done on these holidays. Likewise, producers should know that no animals are kosher slaughtered on Saturdays. Normally, therefore, it is not good business to have too many kosher-type cattle, calves, or lambs on the eastern markets just prior to or during these holidays.

PROMOTIONAL AND RESEARCH ORGANIZATIONS OF IMPORTANCE TO THE LIVESTOCK AND MEAT INDUSTRY

There are a number of nation-wide promotional and research organizations whose business it is to work for the betterment of

the livestock and meat industry. Among these are the National Livestock and Meat Board, the American Meat Institute, the National Association of Retail Meat Dealers, and the National Livestock Loss Prevention Board. The organization, functions, and accomplishments of each of these will be discussed briefly.

The National Livestock and Meat Board

Organized in 1923, the National Livestock and Meat Board has now completed twenty-five years of yoeman service to the livestock and meat industry. The organization of the board is unique in that every major group within the industry is represented. The twenty-two man board is comprised of thirteen representatives of livestock growers and feeders, four representatives of livestock marketing agencies, three representatives of the meat packing industry, and two representatives of the nation's meat retailers. Under the general manager, who is the executive head of the National Livestock and Meat Board, there are the following eight departments: (1) merchandising, (2) home economics, (3) homemakers' service, (4) public relations, (5) nutrition, (6) information, (7) visual education, and (8) research. In addition to conducting an ambitious and effective education program in behalf of meat, the National Livestock and Meat Board finances much worth-while fundamental research in the field of meats at selected colleges and universities throughout the United States.

The National Livestock and Meat Board receives its revenue from voluntary contributions made jointly by livestock growers and meat packers and collected at the time animals are marketed. The grower contributions total 25 cents per single-deck car, with less than carload lots being on the following basis: cattle, 1 cent per head; hogs ½ cent per head; calves, ⅓ cent per head; and sheep, 1 5 cent per head. Unless the seller objects, cooperating markets automatically make these deductions from the proceeds. The packing plants purchasing the livestock contribute a like amount. The National Livestock and Meat Board has its offices at 407 South Dearborn Street, Chicago, Illinois.

The American Meat Institute

The American Meat Institute was founded in 1906 as the American Meat Packers Association, but in 1919 it was reorganized as the Institute of American Meat Packers. Finally, in 1940, it became the American Meat Institute. This is an educational and research organization whose membership includes

about 350 packers here and abroad. Its staff is divided into ten service departments as follows: (1) research; (2) public relations; (3) livestock; (4) packing house practice and research; (5) waste elimination; (6) accounting; (7) industrial education; (8) advertising; (9) marketing; and (10) purchasing practice. The president is the chief executive officer of the organization. The American Meat Institute is rendering meritorious service to the entire livestock and meat industry. It maintains offices at 59 East Van Buren Street, Chicago, Illinois.

The National Association of Retail Meat Dealers

As the name indicates, the National Association of Retail Meat Dealers is an organization of the retail meat dealers of the United States. Although not all members support the national organization, it is noteworthy that an estimated one million workers are engaged in the retail stores of the United States. They are combined under the slogan "One for All and All for One." The organization was founded in 1885, and now there are local organizations in the principal cities from coast to coast. The chief executive officer of the organization is the national secretary-treasurer who is assisted by a board of directors, a legislative committee, a trade-relations committee, and a labor-board committee. The activities of the organization are supported by dues from its membership. The head office is located at 176 West Adams Street, Chicago, Illinois.

The National Livestock Loss Prevention Board

The National Livestock Loss Prevention Board has as its primary objective the reduction of animal diseases and parasites and losses in marketing livestock. It initiates and encourages education and research, correlates and coordinates present activities and information, and promotes practical and proper methods of reducing and eliminating preventable livestock losses during the marketing process. In short, the program of the National Livestock Loss Prevention Board is designed to make for greater efficiency of production. The office of the general manager is located at the Union Stockyards, Chicago; and five regional managers are located at Chicago, Sioux City, Kansas City, South St. Paul, and Omaha.

REFERENCES

Further information relative to marketing as applied to each of the respective classes of livestock is presented in the following books by the same author and the same publisher as *Animal Science:*

Beef Cattle Husbandry

Sheep Husbandry

Swine Husbandry

CHAPTER VII

MEAT AND ANIMAL BY-PRODUCTS[1]

Meat may be defined as the edible flesh of mammals used for food. In a broad sense, the term meat may also include the flesh of fish, shellfish, poultry, and game.

Meat by-products include all products, both edible and inedible, other than the carcass meat. The edible glands and organs are usually classed as by-products, but lard is grouped along with pork.

Although this chapter is devoted to the final animal products —meats—it must be remembered that the top grades of this important food constituent represent the culmination of years of progressive breeding, the best in nutrition, vigilant sanitation and disease prevention, superior care and management, and modern marketing, slaughtering, processing, and distribution. In brief, the efficient availability of the highest quality meats is dependent upon the well-coordinated operation of the whole field of animal science. Much effort and years of progress have gone into the production of luscious steaks or chops.

MEAT THROUGH THE AGES

For thousands of years, meat has been a pillar of the human diet. Primitive man chose it instinctively if not through necessity. At first, it was a matter of securing meats from the wild animals; later, animals were domesticated and eventually used for power and recreation as well as for food and clothing. The story of meat through the ages is a romantic one.

History shows that the meat-eating people of the world have always been the most progressive. They have furnished the impetus to take civilization forward step by step. Where the meat supply is limited in the daily diet, human efficiency, national progress, and health lag behind.

[1]Acknowledgment, with sincere thanks, is given to the following specialists who reviewed Chapter VII: Mr. R. C. Pollock, General Manager, National Livestock and Meat Board, 407 S. Dearborn Street, Chicago, Illinois; and the staff of the American Meat Institute, 59 East Van Buren Street, Chicago 5, Illinois.

Archeological Record of Meat Eating

The development and extension of civilization itself has gone hand in hand with the existence of animals. The fragmentary evidence—mostly in the form of bones and tools collected from buried camp sites, caves, and graves and the carving on the walls of caves or on utensils, tools and weapons—constitutes the first historical record of what is known about early man and his surroundings. From such archeological evidence, it is clear that during the Paleolithic Period (the Old Stone Age)—long



Fig. 97. Expeditionary Force sent to Persia and India in 1670. Formerly live animals had to be carried along to be slaughtered as the army proceeded into uninhabited regions. Today, frozen, dehydrated, and canned meat simplifies the problem. It is also interesting to note that the search for spices for use in meat preservation prompted much of the early-day sailing. (Courtesy, The Bettmann Archive.)

before there were any domestic animals, except perhaps the dog—man hunted down certain animals and used their meat for foods and their skins for clothing. Neolithic man (New Stone Age man) found it more convenient to domesticate animals, thus providing a more stable food supply. He appears to have had nearly all of our domestic animals in Europe, except the cat and poultry and those animals which were found only in America or in the tropics. During the Bronze and Iron Ages, especially the latter period, man began to use animals as a source of power, as well as for food and clothing. Thus, down through the ages, with each succeeding step in his advancing civilization, man became more and more dependent upon animals and animal products.

Early Written Records of Use of Meats

The ancient Egyptian and Babylonian carvings, which are among the oldest of what may be called written records, show that caring for the goat, sheep, ox, ass, pig, dog, and cat was a well-established part of agricultural practice even at that remote time.

But the contribution of meat was not in terms of food alone. Almost all of the primitive people had the legend in some form or other that the roast of sheep and goat was acceptable as an offering to their deities. In ancient Assyria, meat preparation was held semi-sacred, and only the priestly order could engage in it; and in Egypt the food laws stipulated that the priests should serve as judges of meat. Even in Biblical times, the Hebrew patriarchs offered up on their altars burnt offerings of meat to their deities as a gift of their most precious possessions.

In many countries, a man's wealth was measured by the number of cattle he owned. It is interesting to note that the old Latin word for money, "pecunia," from which we get our word "pecuniary," was derived from "pecus," meaning cattle.

Meat Prompted Early Sailing

Down through the ages, meat continued to exert a powerful influence on history. Columbus set forth on his famous voyage of 1492, seeking a shorter route to the East Indies, primarily because it would then be easier to secure needed supplies of spices for Europe. In these early days, refrigeration was unknown, and spices were in great demand to preserve meat and make it more palatable. Likewise, Marco Polo's overland journey to the Far East had much the same incentive behind it.

The Beginning of Meat Cookery

One can merely conjecture that meat cookery was practiced soon after the use of fire in the Old Stone Age (Paleolithic period). Charles Lamb, in his "Dissertation on Roast Pig," gives the legendary account of how the world owes the discovery of roast pork to a naughty Chinese boy. One day Bo-Bo accidentally burned down his father's cottage, and with it a litter of young pigs that were sleeping underneath were burned to death. Perplexed and fearful of what would happen when his father returned, Bo-Bo stooped to feel one of the roasted pigs, burned his fingers, and to cool them popped them into his mouth. He found the roast pork delicious. Then the fantastic story goes on to say that every time the sow farrowed, Bo-Bo's father's house was

sure to be in a blaze. Moreover, the practice spread throughout China until some wise old Chinese philosopher discovered that it was not necessary to burn the house down in order to get roast pork.

How Meats Got Their Names

It is interesting to note how live animals and their respective meats came to be designated as we know them today. The story is that after the Norman conquest of England, the language of the court, or that used by what we would call the "polite set," was Norman-French. But the common people, the keepers of the



Fig. 98. King Charles II was so impressed with a platter of beef that was served at one of his feasts, that — according to an old English legend — he ceremoniously arose, touched his sword to the steaming platter and said, "A noble joint it shall have a title. Loin, I dub thee Knight — henceforth thou shall be Sir Loin." (Courtesy, Picture Post Library, London, England.)

herds and flocks, continued to speak their native Middle English dialects. These native underlings referred to the live animals under their charge as kine, calves, swine, and sheep; and when the servants set the different meats before their feudal masters, they used the names of "Boeuf," "Vielle," "Porc," and "Mutton"



Fig. 99. The crest of Lord Bacon (1561-1626)—noted English Viscount, lawyer, statesman, politician—which depicts a pig. According to some authorities, this explains the derivation of the word bacon. (Courtesy, Picture Post Library, London, England.)

—names which later became established as beef, veal, pork, and mutton. Gradually, as the two nationalities of England fused, the names of the animals and their respective meats became an established part of the English language.

The stories surrounding the names of some of the meat cuts is also fascinating. For example, according to an old English legend which dates back many years, King Charles II was so impressed with a platter of beef that was served at one of his feasts that he ceremoniously arose, touched his sword to the

steaming platter and said, "A noble joint it shall have a title. Loin, I dub thee Knight—henceforth thou shall be Sir Loin." The word "bacon" is said by one authority to have been derived from the old German word "baec," which means "back." However, others express the opinion that the word may have been derived from the noted Englishman, Lord Bacon, for the reason that the crest of Lord Bacon depicts a pig. In support of the latter story, it can be said that bacon has for many years been a favorite item in the English menu. It has also been suggested that the expression, "bringing home the bacon" is of English origin, having grown out of an ancient English ceremony, dating back to the 12th century, which annually took place in a village about forty miles from London. In this ceremony, it was the custom to award a "flitch of bacon" to each couple who, after a year of married life, could swear that they had been happy and had not wished themselves unwed. This 700-year-old tradition was revived in 1949.

The word "porterhouse" as applied to steak dates back to an early Ale and Porter house in New York City which was owned and operated by a gentleman named Morrison. He built up a wide reputation for the specially cut steaks he served, and in due time these became known as "porterhouse" steaks. The name "T-bone" takes its name from the shape of the bone in these steaks.

Meats in Early America

Meat from the native wild animals had, presumably, always formed a major part of the food of the early American Indians. In fact, it is thought that the Red Man taught the first white settlers how to cure and smoke meats. But the colonists were not willing to become nomadic hunters of wild animals. At a very early time, they imported domestic animals from the mother country. Hogs had preceded the Jamestown settlement, having been brought to Tampa Bay (now Florida) by de Soto in 1539. Cattle and sheep were first brought over from England by the colonists in 1609 and 1610, respectively. At first, cattle were primarily used for work purposes, and sheep were valued chiefly for their wool. As grains became more plentiful, however, it was possible to share the crops, other than pasture, with the animals. When this time arrived, meat became an article of trade and a source of income. In fact, the colonists used both grain and pork as sources of money. In early New England, to be destitute of pork was even considered disreputable.

Early American Statesmen Were Meat Eaters

No history of meat animals in the United States would be complete without reviewing the contributions made by George Washington, our first President. Washington was a country boy who never saw a town of five thousand persons until after he was grown. He retained his interest in country life even when he was president, for we are told that as he traveled throughout the states, he always made notations concerning the agriculture of the territory through which he passed. Even today, the beautiful and historic Mount Vernon estate attests of his great interest in livestock. Visitors to Mount Vernon reported that the Washingtons often served as many as four kinds of meat at their prompt two o'clock dinners. The meal at Mount Vernon, according to one visitor, included a small roasted pig, boiled leg of lamb, roasted fowls, beef, peas, lettuce, cucumbers, artichokes, puddings, tarts, and a choice of drinks. The sheep, horses, and cattle on the plantation of the first president were pretty well treated, but we are told that the pigs were self-sustained razor backs of the forest. One Englishman described them as "being shaped like a fish called a perch."

It is also interesting to review a story attributed to Benjamin Franklin. Franklin grew up in a staunch Quaker home in New England and he was chagrined and became restless during the long graces that accompanied his New England meals. So one day after the pork supply had been dutifully stored away, he suggested that if only his father would "say grace over the whole cask, once and for all, it would be a vast saving of time."

Then, too, in considering the history of meats in the United States, we must pause to pay tribute to the immortal Abraham Lincoln. He had the unpleasant task of guiding the destiny of a nation at war, a nation divided against itself. As a boy, Lincoln and his family lived chiefly, or sometimes even exclusively, on meat. He not only lived largely on game for a number of years, but he wore a coonskin cap and often deerskin clothes. Moreover, when he went to school for a while one winter, it was to a log school house, and the teacher apparently took his pay in skins and hams.

MEAT OVER THE BLOCK THE ULTIMATE OBJECTIVE

Except for the wool produced by sheep, meat over the block is the ultimate objective in producing cattle, sheep, and swine. To be sure, this has not always been true. Time was, even in colonial America, when the greatest utility value of cattle was



Fig. 100. A modern meat market. Meat over the block is the ultimate objective in producing cattle, sheep, and swine. Providing America's meat requires 350,000 retail meat dealers who employ about a million persons. (Courtesy, Meat Merchandising.)

as work oxen. The production of meat and milk was purely incidental, and hides were the most valuable product of slaughter. Yet, as feeds and animals increased in abundance, the colonists showed their fondness for beef, as well as for pork and lamb.

Of course, the type of animals best adapted to the production of meat over the block has changed in a changing world. Thus, in the early history of this country, the very survival of animals was often dependent upon their speed, hardiness, and ability to fight. Moreover, long legs and plenty of bone were important attributes when it came time for animals to trail hundreds of miles as drovers took them to market. The Texas Longhorn, Arkansas Razorback, and multi-colored sheep of the Navajo Indians were adapted to these conditions.

With the advent of rail transportation and improved care and feeding methods, the ability of animals to travel and fight diminished in importance. It was then possible, through selection and breeding, to produce meat animals better suited to the needs of more critical consumers. With the development of large cities, artisans and craftsmen and their successors in industry required fewer calories than those who were engaged in the more arduous tasks of logging, building railroads, etc. Simultaneously, the American family decreased in size. The demand shifted, there-

fore, to smaller and less fatty cuts of meats; and, with greater prosperity, high quality steaks and roasts were in demand. To meet the needs of the consumer, the producer gradually shifted to the breeding and marketing of younger animals with maximum cut-out value of the primal cuts. The need was for a blocky conformation, with short legs and a short neck. Instead of marketing large ponderous, fat, three-to-five-year-old steers, baby beef came into prominence; the 600- to 1,000-pound packing hogs were transformed into 200-pound meat-type barrows; and instead of marketing mature sheep as unrelished mutton, the marketing of lamb increased in importance.



Fig. 101. Cattle fashions have changed! "Firly" a prize ox of Britain in 1835; shown at 4 years and 8 months of age and weighing 3,000 pounds. The near animal is Royal Jupiter, the Shorthorn steer that was Grand Champion over all breeds at the 1946 Chicago International; shown by Oklahoma A. & M. College. (Courtesy, The Shorthorn World.)

This change in market demand is reflected in the progressively lighter weights of the grand champion steers exhibited at the International Livestock Show. For example, in the first five years of the show, beginning in 1900, the winning steers averaged 1,693 pounds in weight; whereas in the five years ending with 1946, the average weight was 1,160 pounds, an average decline in weight of 527 pounds per steer.

Thus, throughout the years, consumer demand has always exerted a powerful influence upon the type of animals produced. To be sure, it is necessary that such production factors as pro-

lificacy, economy of feed utilization, rapidity of gains, size, longevity, etc., receive due consideration along with consumer demands. But once these production factors have received due weight, the producers of all meat animals—whether they be purebred or commercial producers—must remember that meat over the block is the ultimate objective.

QUALITIES IN MEATS DESIRED BY THE CONSUMER

Because consumer preference is such an important item in the production of meats, it is well that the farmer and rancher, the packer, and the meat retailer be familiar with these qualities, which are summarized as follows.

1. **Palatability.**—First and foremost, people eat meat because they like it. Palatability is influenced by the tenderness, juiciness, and flavor of the fat and lean.

2. **Attractiveness.**—The general attractiveness is an important factor in selling meats to the housewife. The color of the fat and lean, the degree of fatness, and the marbling are leading factors in determining buyer appeal. Most consumers prefer a white fat and a light or medium red color in the lean.

3. **Moderate amount of fat.**—Middle- and low-income groups discriminate against too much fat, especially when it must be trimmed heavily.

4. **Small cuts.**—Most purchasers prefer to buy cuts of meat that are of a proper size to meet the needs of their respective families. Because the American family has decreased in size, this has meant smaller cuts. This, in turn, has had a profound influence on the type of animals and on market age and weight.

5. **Ease of preparation.**—In general, the housewife prefers to select those cuts of meat that will give her the greatest amount of leisure time. Steaks of beef and chops of lamb and pork can be prepared with greater ease and in less time than can roasts or stews. Hamburger and sausage are also easy to prepare.

NEED FOR MEAT GRADING

Slaughtering and selling meats has progressed from a purely local enterprise to a highly complex system. The early-day "butcher" bought animals on the hoof, did his own slaughtering, and sold the meat to his neighbors and friends. There were no standard wholesale cuts. In fact, the carcass was usually halved and then meat was cut from end to end, with the particular loca-

tion of the cut obtained by any purchaser being determined largely by the progress in cutting the carcass at the time the purchase chanced to be made. Neither was there any grading. Based on the quality of animals purchased, some butchers simply acquired a reputation for supplying better meats than others.



Fig. 102. Early-day (about 1840) Butcher Shop, from a painting by W. S. Mount (1807-1869). There were neither standard wholesale cuts nor grades. The carcass was usually halved and the meat was cut from end to end, with the particular location of the cut obtained by the purchaser determined by the progress in cutting the carcass at the time the purchase chanced to be made. (Courtesy, The Bettmann Archive.)

With the westward expansion, the development of large meat packing plants nearer the source of production, and the advent of meat shipment in refrigerated cars, the slaughterers and consumers tended to become more widely separated. Because an individual retailer usually could not handle an entire carlot of meat, the wholesaler took over the assignment of buying large quantities of meats from packers and selling in small lots to individual retailers. But it was no longer practical for the eastern meat buyer to personally inspect and purchase meat supplies from packers located many miles to the west. To a lesser extent, many retailers found it a nuisance to go to the wholesaler's ware-

house to inspect the meats before buying. It was further realized that price is not always an indication of quality in meats and that most meats look alike to the inexperienced buyer and consumer. Thus, there was a need for some practical and standard means of describing quality in meats. Out of this need has arisen four systems of meat grading: (1) federal grading; (2) American Meat Institute grading; (3) packer brands; and (4) O.P.A. grades, which are now obsolete.

Packer brands are usually used in combination with either federal grades or institute grades. The O.P.A. grades were strictly a war-time measure and are no longer used. Regardless of the system used, it is generally acknowledged that carcass grading is a far more accurate evaluation of the value of slaughter animals than can be arrived at on foot, even by experienced packer buyers ("dark cutters" cannot be detected prior to slaughter).

EARLY GRADE TERMS WERE CONFUSING

Prior to establishing federal grading, each packing plant and meat market had a certain vocabulary peculiar to itself and most likely not known to other markets. Nor was there any particular correlation between designations on foot and in carcass form. In a broad way, the early terms emphasized the geographical origin of animals. It was common to refer to "native" or "western" beef and lamb. Presumably, the "native" carcasses were from grain-fed animals; whereas the "western" carcasses were from grass fat animals. Yet, it was soon realized that these designations were inaccurate because many western cattle and lambs are now grain fed, either in the Corn Belt or in the irrigated valleys of the West. Many so-called native cattle and lambs received no grain whatsoever prior to marketing. At most markets, the broad classifications, "native" and "western" were further subdivided to show narrower ranges of quality, such as "choice," "good," and "medium" natives or westerns, respectively. Yet, these designations had very different connotations on different markets. Both buyers and sellers of meats were in a constant state of confusion, especially in going to a different market; and misunderstandings could not be avoided without a personal inspection.

FEDERAL GRADING

A scientific study of meat grading was first undertaken by the University of Illinois, beginning in 1902. The results of these studies were used as a basis by the U. S. Department of Agricul-

ture workers in setting up tentative standards for classes and grades of beef carcasses. They were first used in market news reporting work in 1916. As would be expected in such pioneering and in a changing industry, several revisions of the early meat standards have been made through the years, thus keeping them in line with consumer demands and production practices.

Federal grading of beef was first started as a special service to United States Steamship Lines in 1923; and on February 10,

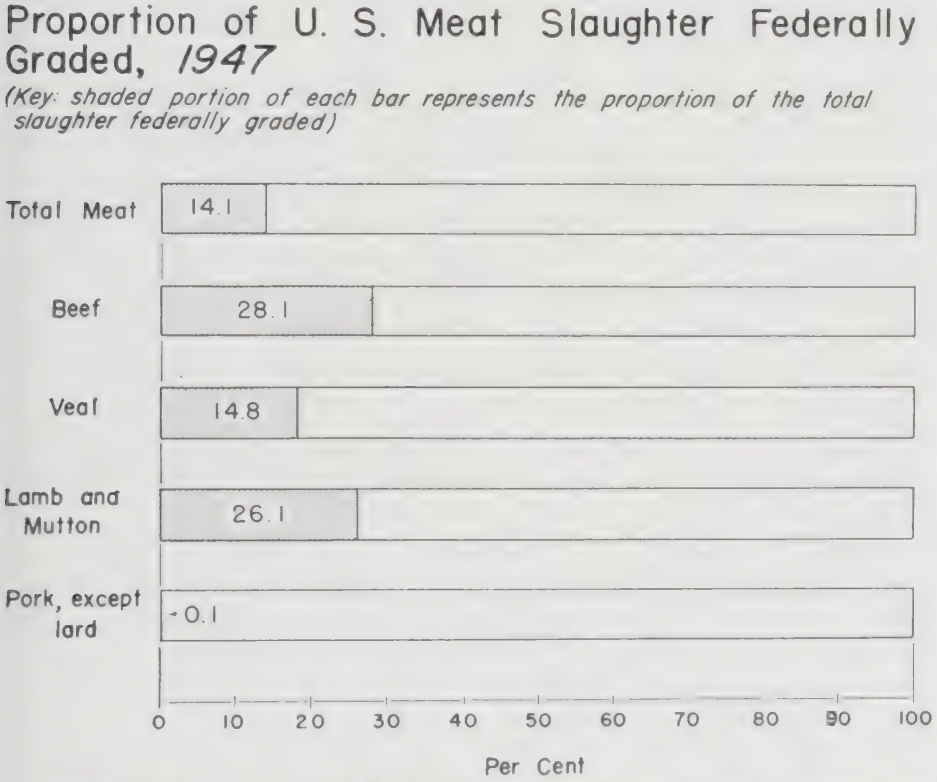


Fig. 103. Proportion of U. S. meat slaughter (including federally inspected, non-federally inspected, and farm slaughter) federally graded in 1947. (Drawing by R. F. Johnson.)

1925, the 68th U. S. Congress passed an act setting up a federal meat grading service. But commercial meat grading was not inaugurated until 1927, at which time "Prime" and "Choice" grades of steer and heifer beef were stamped at Boston, New York City, Philadelphia, Washington, Chicago, Omaha, and Kansas City. A year later, the "Good" grade was added, and finally the service was broadened to include beef of all classes and grades.

At first, federal grading of meats was limited to beef, but it now includes mutton, lamb, calf and veal carcasses. Pork car-

casses have not been federally stamped because it is claimed that the grade stamp would be removed when the fat is trimmed from the different cuts. But it would appear that this difficulty will soon be overcome, especially if rail grading of pork should come into practice in this country.

Government grading, unlike meat inspection, was not compulsory prior to July 13, 1942. During the period of World War II, O.P.A. grading was required as a part of price controls, but following the war the service was again placed on a permissive basis. Official graders are subject to the call of anyone who wishes their services, (packer, wholesaler, or retailer) with a charge of $3.00 per hour being made (with a minimum charge of $1.50). The time includes both travel and the actual time required to do the grading. Government meat graders are appointed from a list of eligibles submitted by the Civil Service Commission. To qualify, a candidate must have had at least six years of suitable practical experience in wholesale meat marketing or grading. Beginners are also trained for a period of time under experienced graders. Government meat graders are now stationed in ninety important meat centers. Figure 103 shows the proportion of the total United States meat slaughter (including federally inspected, nonfederally inspected, and farm slaughter) which was federally graded in 1947. It is noteworthy that only 14.1 per cent of all meats were federally graded during the year. No farm-produced meat is federally graded, but a limited amount of federal grading is used by some plants that do not have federal inspection for sanitation.

The Federal Grades of Meats

The grade of meat may be defined as a measure of its degree of excellence based on conformation, finish, and quality. The specifications for each grade are sufficiently definite to make for uniform grades throughout the country and from season to season.

Effective in July, 1939, the sex identification of steer, heifer, and cow beef was entirely dropped from federal grades. It was not intended that this move should be construed to mean that there is no carcass difference between the different sex classes. As a matter of fact, it is generally recognized that there is a pronounced difference between the sex classes of cattle, with a lesser difference between the sex classes of sheep and hogs. Rather, this step in simplification was taken so that it might be easier for the buyer or consumer to buy meat on the basis of

TABLE 14

PRESENT (SINCE DECEMBER 29, 1950) AND FORMER U.S.D.A. GRADES OF BEEF CARCASSES[1]

(Steer, Heifer, and Cow Beef)

Present USDA Grades	Former USDA Grades	Summary of Grade Changes Effective December 29, 1950
Prime (Cow beef is not eligible for the Prime grade)	Prime	The former Prime and Choice grades were combined under the name Prime
	Choice	
Choice	Good	The former Good grade was renamed Choice
Good	Commercial	The former Commercial grade was divided, with (1) the top carcasses from the younger cattle therein renamed Good and (2) the beef from the lower quality younger cattle and that from the older cattle in this group continuing as Commercial.
Commercial		
Utility	Utility	The three bottom grades remained unchanged.
Cutter	Cutter	
Canner	Canner	

[1]In rolling meat, the letters "U. S." precede each federal grade name. This is important, as only government-graded meat can be so marked. For convenience, however, the letters "U. S." will not be used in the tables and discussions that follow.

quality, without the added confusion that accompanies a more complicated system.

Effective December 29, 1950, the federal standards or specifications for each of the four top grades of beef carcasses were changed. The three bottom grades remained the same. These changes, which are clearly set forth in Table 14, (1) reflect modern beef production practices and consumer preferences for younger beef, smaller cuts, and moderate finish, and (2) make the top grades more usable, for formerly only two-tenths of 1 per cent of all beef graded Prime. At the present time, therefore, the seven standard federal grades of beef are: Prime, Choice, Good, Commercial, Utility, Cutter, and Canner. Cow beef is not eligible for the Prime grade. Other than the latter stipulation, no sex differentiation or identification exists in graded beef obtained from steers, cows, and heifers.

Effective March 10, 1951, similar revisions were made in the top four grades of veal and calf carcasses, with the Utility and Cull grades remaining unchanged. These revisions placed veal

and calf carcasses in line with the new beef grades. Thus the present grades of veal and calf carcasses are: Prime, Choice, Good, Commercial, Utility, and Cull.

Bull and stag beef is identified by class as "bull" beef and "stag" beef, respectively. Within each of these classes, there are the following six grades: Choice, Good, Commercial, Utility, Cutter, and Canner. However, no designated grade of bull beef or of stag beef is comparable in quality to a similarly designated grade of beef obtained from steers, heifers, or cows. Neither is the quality in a designated grade of bull beef comparable to a similarly designated grade of stag beef.

On April 30, 1951, the number of grades of lamb and mutton was reduced from six to five, and the Commercial grade was eliminated. These changes are clearly set forth in Table 15. As noted, the Prime grade was limited to lamb and yearling carcasses, with Choice being the top grade for which mutton carcasses are eligible.

The Cull grade of lamb and mutton, and veal and calf is the counterpart of both the Cutter and Canner grades of beef. It is seldom that any of these lower grades are sold as retail cuts. The consumer, therefore, only needs to become familiar with the upper grades of each kind of meat.

TABLE 15

PRESENT (SINCE APRIL 30, 1951) AND FORMER U.S.D.A. GRADES OF LAMB AND MUTTON CARCASSES

Present USDA Grades	Former USDA Grades	Summary of Grade Changes Effective April 30, 1951
Prime (Limited to lamb and yearling carcasses)	Prime	The former Prime and Choice grades were combined under the name Prime.
	Choice	
Choice	Good	The former Good grade was renamed Choice.
Good	Commercial	The upper 2/3 of the former Commercial grade was renamed Good.
Utility		The remaining 1/3 of the former Commercial grade was combined with the upper 2/3 of the Utility grade and named Utility.
	Utility	
Cull	Cull	The remaining 1/3 of the Utility grade was combined with the Cull grade.

Most pork produced in the United States is more uniform in quality than is any other class of meat, and therefore there is need for fewer grades. Instead of having seven grades of meat as exist in beef, there are the following five *tentative* grades of pork carcasses: Choice No. 1, Choice No. 2, Choice No. 3, Medium, and Cull. These grades are based on (1) the relationship between carcass measurements (average back fat thickness from three measurements—opposite first and last ribs and last lumbar vertebra—and carcass weight or length), (2) lean cut yields (per cent of the carcass weight in the four major lean cuts; namely, hams, loins, picnics, and Boston butts), and (3) quality of cuts. The Choice No. 1, Choice No. 2, and Choice No. 3 grades are comparable in that all produce Choice quality cuts, but the grades differ progressively in fatness and in yield of lean cuts. (Choice No. 1 having the minimum degree of finish and the maximum yield of lean cuts associated with choice quality. The Medium and Cull grades produce higher yields of lean cuts, but the quality is inferior to that in the choice grades).

Factors Determining Federal Grades

Because federally graded meats are so stamped that the grade will appear on the retail cuts as well as the carcass and wholesale cuts, the consumer will find it helpful to understand the factors on which meat grading is based. The following are definitions of the grade factors as they apply to meats, both carcasses and wholesale cuts, coming from all species:

CONFORMATION:

Conformation refers to the general build, form, shape, contour or outline of the carcass, side, or cut. Superior conformation implies a plump, stocky, or blocky carcass, with short neck and shanks, full loins, deep, plump rounds, well-fleshed ribs, and smooth shoulders. This is in contrast to ranginess and angularity. Such conformation assures retail cuts that will be shapely and have full muscles and a large percentage of edible meat to bone and that will make for the maximum cut-out value of primal cuts.

FINISH:

Finish refers to the amount, quality, and distribution of fat. Superior finish implies a smooth, even covering of fat over most

[1]In July, 1951, these were tentative, but the U.S.D.A. was in the process of preparing a formal proposal to have them promulgated as official standards.

of the exterior surface of the carcass, a much thinner covering over the interior surface of the ribs, and a liberal intermixture of fat with lean, called marbling. In grading, it is recognized that the degree of finish and marbling is related to some extent to the age of the animal from which it is produced. Thus less finish and marbling is required for top-grade meats obtained from younger animals, but it is necessary that the character of the fat and the conformation and quality meet the degree of perfection required for the grade.

QUALITY:

Quality refers to the eating quality of the meat and is indicated by certain characteristics of the fat and lean tissue, the bone, and the marbling. Superior quality implies well marbled lean that is firm and fine in texture, a minimum of connective tissue, and a desirable color of lean typical of the species. The finish is also firm (not soft or oily) and the meat is produced from young animals as indicated by the bones. Quality is considered

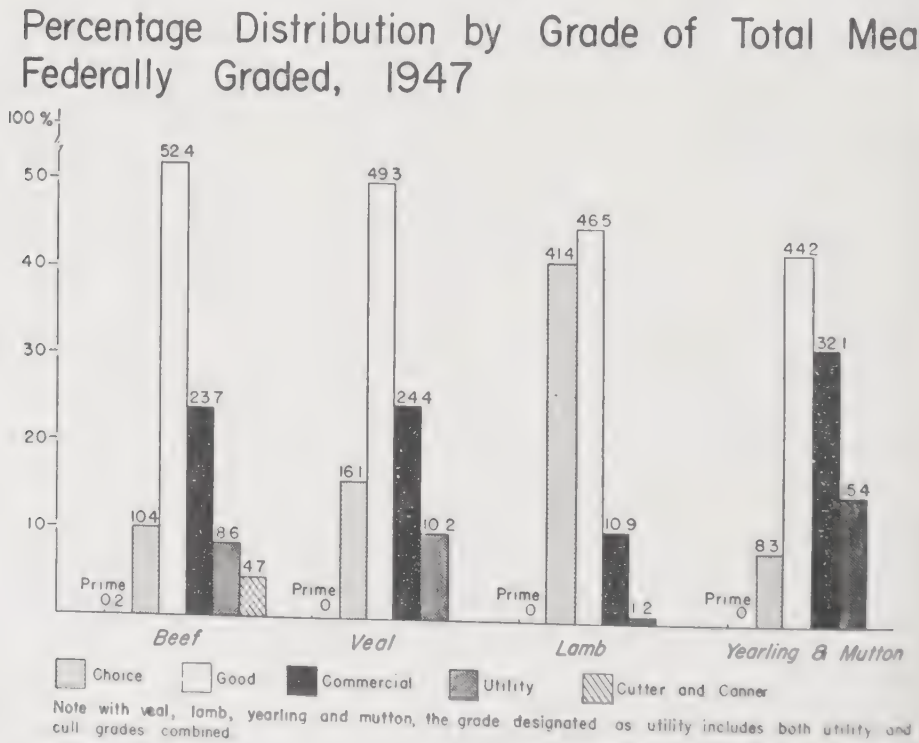


Fig. 104. Percentage distribution by grades of the total meats graded in 1947, using the old grade specifications or standards which were employed prior to December 29, 1950. It is noteworthy that only 0.2 per cent of the total beef slaughter graded "U. S. Prime," and that none of the veal, lamb, and yearling and mutton was given this top grade. (Data kindly furnished by Harold F. Breimyer, U.S.D.A. Drawing by R. F. Johnson.)

the most important of the three grade factors because it furnishes for consumers the most dependable criterion of the merit of meat.

As would be expected, in order to grade "U. S. Prime," the carcass or cut must possess a very high degree of conformation, finish, and quality. The lower grades of meats are deficient in one or more of these factors determining grade. Because each grade is determined on the basis of a composite evaluation of all three factors (conformation, finish, and quality), a carcass or cut may possess some characteristics that are common to another grade. It must also be recognized that all of the wholesale cuts produced from a carcass are not necessarily of the same grade as the carcass from which they are secured. Figure 104 gives the percentage distribution by grades of the total meats graded in 1947, using the old grade specifications or standards employed prior to December, 1950. In 1947, beef grading was on a permissive basis. It is noteworthy that only 0.2 per cent of the total beef slaughter graded "U. S. Prime," and that none of the veal, lamb, and yearling and mutton was given this top grade.

Applying the Grade Stamp

After careful examination of the carcass (or wholesale cut) from the standpoint of conformation, finish, and quality, the grader arrives at what he considers the proper grade. He then applies a roller stamp on the entire length of the carcass and at such other points that all the principal retail cuts will bear the grade label. In this stamping process, as well as in all other meat marking processes, a harmless vegetable dye is used. It is unnecessary, therefore, that the dye be trimmed from the meat.

Advantages and Disadvantages of Federal Meat Grading

Any system of evaluating products is certain to possess advantages and disadvantages, and meat grading is no exception.

Some of the advantages of competent federal grading are:

1. Because the federal grade is applied by an independent agency, rather than an employee of the packing house, the average consumer is less likely to question it. Moreover, it reduces possible misunderstanding between buyers and sellers of meats.

2. The average consumer is not a good judge of the quality of the various kinds of meat that are on display. However, if the meat were correctly graded and labeled, the consumer would be in a position to select the grade that meets his particular requirements.

3. Because there are fewer federal grades, the consumer is likely to become familiar with their significance more readily than with the more numerous Meat Institute numbers and the still more numerous packer brands.

4. Federal grading facilitates large-scale purchasing by federal, state, county, and city institutions and by hotels, restaurants, dining cars, and other large users of meats, chiefly because they can place large orders through one or several channels and obtain uniform products. Such large orders are usually on a contract basis, with grade specifications set forth.

5. The federal grades of meats correspond rather closely to the on-foot grades. They therefore provide a very important correlation for the benefit of producers. The payment of a premium for a quality product is a definite stimulation to improved breeding and feeding.

6. There is hardly any limit to the packer brands as established by different companies; whereas the federal grades are identical regardless of the area or ownership of the plant.

7. It is but natural that there should be less area or seasonal variation in appraisal of meat value or grades when a large overall agency is functioning than when men are trained by many organizations, with only limited effort toward standardization between them.

8. Federal grading avoids any suspicion or temptation of up-grading, an alleged practice when demand for top grades exceeds the supply.

9. It makes meat market reports more intelligible.

10. The purchaser need not inspect carcasses or wholesale cuts to secure uniform products of merit to meet his requirements.

Some of the disadvantages of federal grading are:

1. It ignores sex classes that are important. It would hardly be expected that a cow carcass grading "U. S. Good" could be comparable to a steer carcass of the same grade.

2. It does not provide sufficiently narrow classifications for a critical trade.

3. Many feel that packer brand names are more alluring to buyers than the rather unglamorous federal grades. Naturally, this feeling has been encouraged through advertising.

4. A meat packer's reputation is an individual proposition more than a collective one. It is argued, therefore, that he is more likely to uphold the reputation of his particular brand.

5. The national packers prefer advertising their brand names, claiming that to advertise federal grades places them in the position of helping the small packer, who does little or no advertising but who would greatly benefit therefrom.

AMERICAN MEAT INSTITUTE SYSTEM OF GRADING

Claiming that government grades are too wide (too few in number to meet trade requirements), the meat packing industry has devised its own system of beef classes and grades. This system, which was put into effect by the Institute of American Meat Packers (now the American Meat Institute) in January, 1931, provides for ten grades and gives to each grade a number, using "0" for the top grade and "9" for the bottom grade. A few packers also use additional grades or subgrades of their own. Like federal grading, the Institute System of grading is based on conformation, finish, and quality. It differs from the federal system chiefly in that consideration is given to sex classes and it provides ten grades instead of seven as used in federal grading.

TABLE 16

COMPARISON BETWEEN PRESENT AND FORMER USDA GRADES, AND AMERICAN MEAT INSTITUTE (AMI) GRADES OF CARCASS BEEF
(steer, heifer, and cow beef)

Present U.S.D.A. Grades[1] (steer, heifer, and cow beef)	Former U.S.D.A. Grades, (steer heifer, and cow beef)	AMI Grades (steer and heifer beef)	AMI Grades (cow beef)
Prime[2]	Prime	0	No. U.S.D.A. Prime Cow Beef
	Choice	1	
		2	
Choice	Good	3	1
Good	Commercial	4	2
Commercial		5	3
Utility	Utility	6	4
		7	5
Cutter	Cutter	8	6
			7
Canner	Canner	9	8
			9

[1]Based on grade specifications or standards which became effective in December, 1950.

[2]Cow beef is not eligible for prime grade.

Under the institute system, the packer may designate the sex classes (steer, heifer, cow, bull, and stag) simply by prefixing the institute name by a certain number, but different packers use different numbers to represent each of the sex classes. In a certain plant the prefixes used may be as follows: "1" for steer, "2" for heifer, "3" for cow, "4" for bull, and "5" for stag. With this system, "10" would indicate prime steer beef; the prefix "1" would designate steer beef and the "0" the top grade.

In addition to the sex classes and grades, there are also carcass weight divisions ranging from 400 to 1,200 pounds, in either 50- or 100-pound differentials. It is therefore obvious that when sex classes, grades, and weight divisions are all taken into consideration, the subdivisions number into the hundreds.

In the institute system, the grading is done by the employees of the packing company. The numbers are not stamped on the carcass but are merely marked on tags which are hooked to the carcass in the packing plant and removed before the carcass is delivered to the retailer. Thus, the institute grades are never seen by the consumer, but they are a great aid to packer salesmen and retail meat dealers in transacting their business.

Table 16 shows the comparison between the two grading systems, as well as a comparison with and between the USDA standards (both old and new). It will be noted that in one case a federal grade covers two institute grades and in another three. Although no cow beef qualifies for U. S. Department of Agriculture grade of "Prime," the Institute does assign its second top grade to this sex class, and the packer usually prefixes it with his own sex class designation. The largest percentage of all beef sold to retail dealers is on the basis of institute grades.

PACKER BRAND NAMES

In addition to the institute grades, practically all packers identify their higher grades of meats with alluring private brands so that the consumer as well as the retailer can recognize the quality of a particular cut. Thus the top brand names synonymous with the names of the four largest national meat packers and applied to their highest quality beef, pork and lamb are: Armour's *Star*, Swift's *Premium*, Wilson's *Certified*, and Cudahy's *Puritan*.

A meat packer's reputation depends upon consistent standards of quality for all meats that carry his brand names. The brand names are also effectively used in advertising campaigns.

O.P.A. GRADING

Effective July 13, 1942, and for the duration of price controls in the war years—under the Office of Price Administration—all beef, veal, lamb, and mutton sold at wholesale had to be federally graded according to government specifications. From Sept. 1942 to Dec. 1946, the grade prime was suspended. The grades "prime" and "choice" were combined into a new grade designated as "AA," the good grade was designated "A," the commercial grade "B," the utility grade "C," and cutter grade, "D."

KOSHER MEATS

The Hebrew word "kosher" means clean, and this is the guiding principle in the handling of meats for the Jewish trade. Beef, veal, lamb, and mutton—but not pork—are koshered.

Contrary to common belief, both forequarters and hindquarters of kosher slaughtered meat may be used by orthodox Jews. But because all veins must be removed before the meat is delivered to the consumer, the Jewish trade usually confines itself to the forequarters, from which the veins can be removed with a minimum of tearing of the flesh. In order to de-vein a hindquarter, it is necessary to cut it up into such small pieces that it is very unattractive and unsaleable for anything but ground meat or stews. Because the forequarters do not contain such choice cuts as the hinds, the kosher trade attempts to secure the best possible fores; thus this trade is for high-grade slaughter animals.

The meat must be sold by the retailer within seventy-two hours after slaughter, or it must be washed (a treatment known as "begiss" meaning to wash) and reinstated by a representative of the synagogue every subsequent seventy-two hours. At the expiration of 216 hours after the time of slaughter, however, it is declared "trafeh," meaning forbidden food, and is automatically rejected for kosher trade. It is then sold in the regular meat channels. Because of these regulations, kosher meat is moved out very soon after slaughter. Also it is easier to de-vein the meat while it is still warm than after it has been chilled.

Kosher sausage and prepared meats are made from meats which are deveined, soaked in water one-half hour, sprinkled with salt to stand for an hour, and washed thoroughly. This makes them kosher indefinitely.

The Jewish law also provides that before kosher meat is cooked, it must be soaked in water for one-half hour. After soaking, the meat is placed on a perforated board in order to drain off

the excess moisture. The meat is then sprinkled with salt. One hour later, it is thoroughly washed. It is then considered to remain kosher as long as it is fresh and wholesome.

As would be expected, the volume of kosher meat is greatest in those eastern seaboard cities where the Jewish population is most concentrated. New York City alone uses about one-fourth of all the beef koshered in the United States.

THE NUTRITIVE QUALITIES OF MEATS

Perhaps most people eat meats simply because they like them. They derive a rich enjoyment and satisfaction therefrom. For flavor, variety, and appetite appeal, meat is unsurpassed.

But meat is far more than just a very tempting and delicious food. From a nutritional standpoint, it contains certain essentials of an adequate diet. This is important, for how we live and how long we live are determined in large part by our diet. The nutritive qualities of meats may be summarized as follows:

1. **Proteins.**—The word "protein" is derived from the Greek word "proteous," meaning "in first place." Protein is recognized as a most important body builder. Fortunately, meat contains the proper quality and quantity of protein for the building and repair



Fig. 105. Ham slice, prepared by boiling. Perhaps most people eat meats simply because they like them. For flavor, variety, and appetite appeal, meat is unsurpassed. (Courtesy, American Meat Institute.)

of body tissues. That is, it contains all of the so-called amino acids, or building stones, which are necessary for the making of new tissue.

2. **Calories.**—Meat is a rich source of energy, the energy value being dependent largely upon the amount of fat it contains. A pound of moderately fat beef provides about 1,350 calories, or nearly half the daily energy requirement of the average adult.

3. **Minerals.**—Minerals are necessary in order to build and maintain the body skeleton and tissues and to regulate body functions. Meat is a rich source of several minerals but is especially good as a source of phosphorus and iron. Phosphorus com-

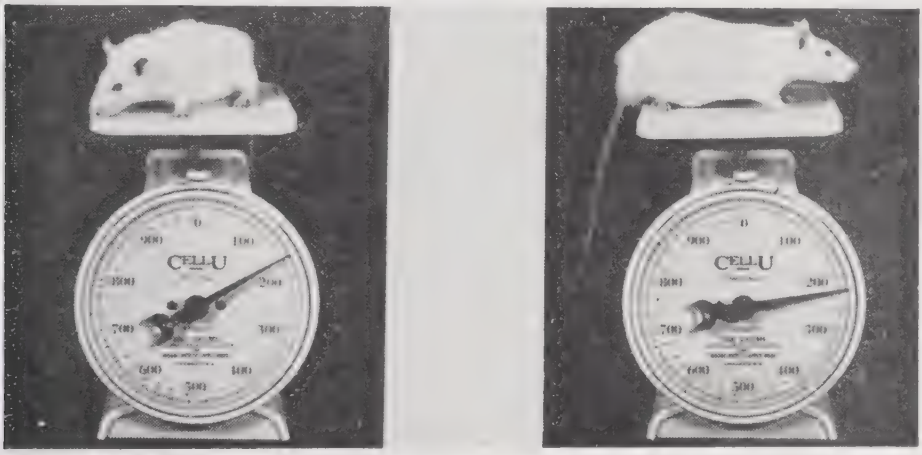


Fig. 106. Shows that meat is a good source of phosphorus. Minerals are necessary in order to build and maintain the body skeleton and tissues and regulate body functions. Although meat is a rich source of several minerals, it is especially good as a source of phosphorus and iron. (Demonstration conducted by the National Livestock and Meat Board in the laboratory of Rush Medical College.)

bines with calcium in building the bones and teeth. Phosphorus also enters into the structure of every body cell, helps to maintain the alkalinity of the blood, is involved in the output of nervous energy, and has other important duties.

Iron is necessary for the building of blood, and its presence protects against nutritional anemia. With these important functions, however, it is interesting to know that the iron in the body of an average adult is equivalent to only about the weight of a penny, yet it enters into the structure of every active body cell. Iron is a constituent of the hemoglobin or red pigment of the 25 trillion or more body corpuscles. Thus it helps to carry the life-giving oxygen to every part of the body. In 1934, Doctors Minot, Murphy, and Whipple were jointly awarded the Nobel

Prize in Medicine for the discovery that liver was effective in the treatment of anemia, a disease which once was regarded as fatal. The average adult would be assured an adequate supply of iron if two servings of meat were taken daily along with one serving of liver each week.

4. **Vitamins.**—Today we have become vitamin conscious. Even so, the word vitamins is not very old. In fact, it was not until the year 1912 that Dr. Casimar Funk, a Polish physician, originated the word. He coined it from the word vita, meaning life. Although the name vitamins is recently new and we are still

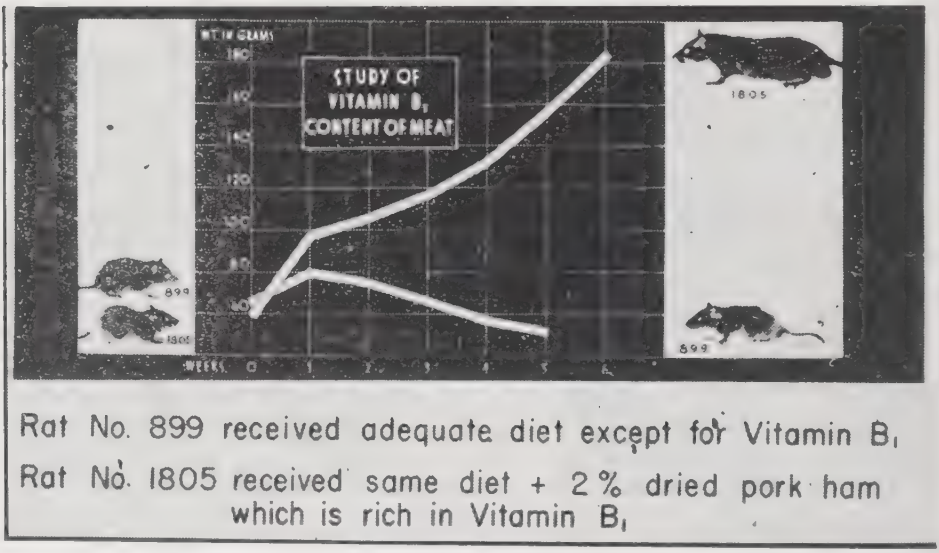


Fig. 107. Meat is a good source of vitamin B_1 (or thiamine). Vitamin B_1 stimulates appetite, prevents beriberi, aids in the utilization of carbohydrates, and promotes the health of the body cells. (Studies by Dr. C. A. Elvehjem, University of Wisconsin; supported by National Live Stock and Meat Board.)

making discoveries relative to these substances, thousands of years ago people knew that certain foods possessed certain nutritive properties. For example, as early as 1500 B. C. the Egyptians and Chinese hit upon the discovery that eating livers would improve one's vision in dim light. We now know that livers furnish vitamin A, a very important factor for night vision. In fact, medical authorities recognize that night blindness, glare blindness, and poor vision in dim light are all common signs pointing to the fact that the person so affected is not getting enough vitamin A in his diet.

Recent work by Dr. C. A. Elvehjem of Wisconsin has shown that meat is one of the richest sources of the important

B group of vitamins. Three valuable vitamins of this group are thiamine, riboflavin, and niacin—the vitamins now being used to reinforce certain foods and which are indispensable in our daily diet. The thiamine stimulates appetite, prevents beri-beri, aids in the utilization of carbohydrates, and promotes the health of the body cells. Riboflavin is necessary for cell oxidation and protects against nervous disorders and also liver disturbances. Niacin prevents and cures pellagra, a diet deficiency disease which has afflicted hundreds of thousands of persons in this country, especially in the South.

We come to realize, therefore, the important part that meat is playing in the nutrition of the nation. It should play an even greater part, for we are told that 35 to 40 per cent of our population is now failing to receive an adequate diet to maintain health and vigor.

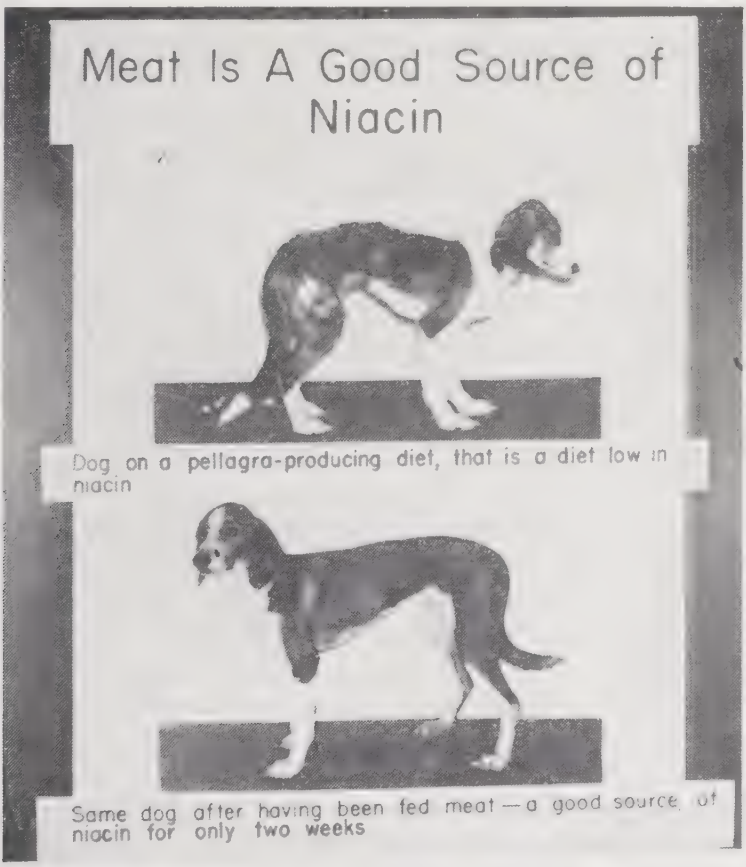


Fig. 108. Meat is a good source of niacin which prevents and cures pellagra in man and "black tongue" in dogs. (Studies by Dr. C. A. Elvehjem, University of Wisconsin; supported by National Live Stock and Meat Board.)

5. **Digestibility.**—Finally in considering the nutritive qualities of meats, it should be noted that this food is highly digestible. About 97 per cent of meat proteins and 95 per cent of meat fats are digested.

WHAT DETERMINES MEAT PRICES

During those periods when meat is high in price, especially the choicest cuts, there is a tendency on the part of the consumer to blame either or all of the following: (1) the farmer or rancher, (2) the packer, (3) the meat retailer, or (4) the government. Such criticisms, which often have a way of becoming quite vicious, are not justified. Actually, meat prices are determined by the laws of supply and demand; that is, the price of meat is largely dependent upon what the consumers as a group are able and willing to pay for the available supply.

The Available Supply of Meat

Because the vast majority of meats are marketed on a fresh basis rather than cured and because meat is a perishable product, the supply of this food is very much dependent upon the number and weight of cattle, sheep, and hogs available for slaughter at a given time. In turn, the number of market animals is largely governed by the relative profitability of livestock enterprises in comparison with other agricultural pursuits. That is to say, farmers and ranchers—like any other good business men—generally do those things that are most profitable to them. Thus a short supply of market animals at any given time usually reflects the unfavorable and unprofitable production factors that existed some months earlier and which caused curtailment of breeding and feeding operations.

Historically, when short meat supplies exist, meat prices rise, and the market price on slaughter animals usually advances, making livestock production profitable. But, unfortunately, livestock breeding and feeding operations cannot be "turned on and off like a spigot." For example, a heifer cannot be bred until she is about 1½ years of age; the pregnancy period requires another 9 months; for various reasons only an average of 63 out of 100 cows bred in the United States conceive and give birth to young; and finally, the young are usually grown and fed until at least a year and a half of age before marketing. Thus, under the most favorable conditions, this production process, which is controlled by the laws of nature, requires 3¾ years in which to produce a new generation of market cattle.

History also shows that if livestock prices remain high and feed abundant, the producer will step up his breeding and feeding operations as fast as he can within the limitations imposed by nature, only to discover when market time arrives that too many other producers have done likewise. Overproduction, disappointingly low prices, and curtailment in breeding and feeding operations are the result.

Nevertheless, the operations of livestock farmers and ranchers do respond to market prices, producing so-called cycles. Thus the intervals of high production, or cycles, in cattle occur about every fifteen years. In sheep they occur about every eight to ten years, and in hogs—which are litter bearing, breed at an earlier age, have a shorter gestation period, and go to market at an earlier age—they occur every five years.

The Demand For Meat

The demand for meat is primarily determined by buying power and competition from other products. Stated in simple terms, demand is determined by the spending money available and the competitive bidding of some 35 million housewives who are the chief home purchasers of meats. On a nation-wide basis, a high buying power and great demand for meats exists when most people are employed and wages are high.

It is also generally recognized that in boom periods—periods of high personal income—meat purchases are affected in three ways: (1) more total meat is desired; (2) there is a greater demand for the choicest cuts; and (3) because of the increased money available and shorter working hours, there is a desire for more leisure time, which in turn increases the demand for those meat cuts or products that require the minimum of time in preparation (such as steaks, chops, and hamburger). In other words, during periods of high buying power, people not only want more meats, but they compete for the choicer and easier prepared cuts of meats—porterhouse and T-bone steaks, lamb and pork chops, hams, and hamburger (chiefly because of the ease of preparation of the latter).

Because of the operation of the old law of supply and demand, when the choicer and easier prepared cuts of meats are in increased demand, they advance proportionately more in price than the cheaper cuts. This results in a great spread in prices, with some meat cuts very much higher than others. While porterhouse steaks, or pork or lamb chops, may be selling for four or five times the cost per pound of the live animal, less desirable

cuts may be priced at less than the cost per pound of the animal on foot. After all, a market must be secured for all the cuts.

But the novice may wonder why these choice cuts are so scarce, even though people are able and willing to pay a premium for them. The answer is simple; nature does not make many choice cuts or top grades, regardless of price. Moreover, a hog is merely born with two hams, a lamb with two hind legs; and only two loins (a right and a left one) can be obtained from each

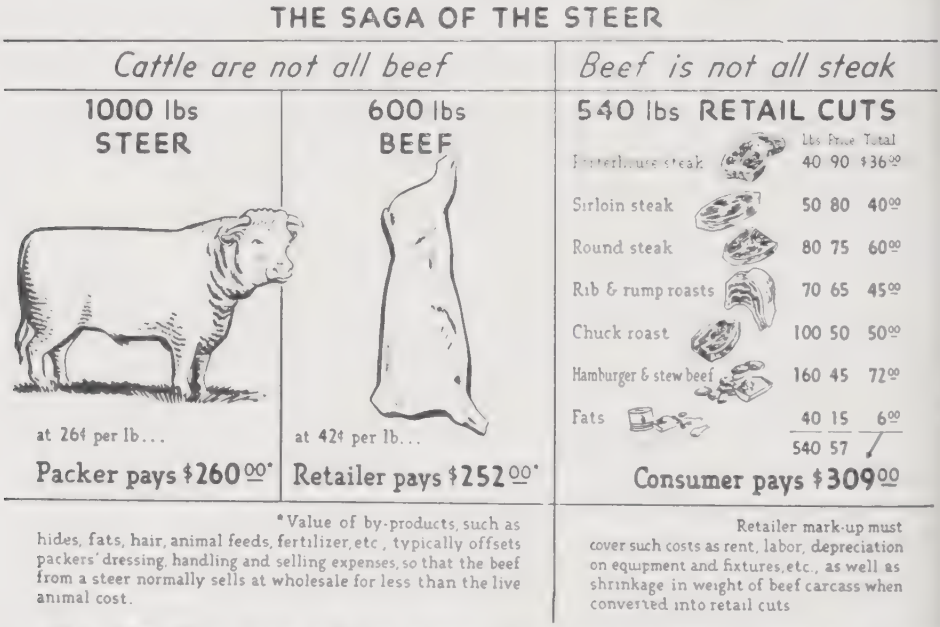


Fig. 109. The saga of the steer. The average steer weighing 1,000 pounds on foot and grading "good" will yield only 540 pounds of retail cuts (the balance consists of hide, internal organs, etc.). This 540 pounds will cut out only about 40 pounds of porterhouse steaks. On a free market, meat prices are determined by the laws of supply and demand. (Prepared by American Meat Institute. Based upon market reports of the U.S.D.A. for good grade beef steers and good grade carcass beef Chicago style cutting and upon average retail prices for good grade meat, as reported by the BLS. Chicago, during 1947.)

hog carcass upon slaughter. In addition, not all weight on foot can be cut into meat. For example, the average steer weighing 1,000 pounds on foot and grading "Good" will only yield 540 pounds of retail cuts (the balance consists of hide, internal organs, etc.). Secondly, this 540 pounds will cut out only about 40 pounds of porterhouse steaks. The balance of the cuts are equally wholesome and nutritious; and although there are other steaks, many of the cuts are better adapted for use as roasts, stews, and soup bones. To make bad matters worse, not all cattle are of a quality suitable for the production of steaks. For example, the

meat from most worn-out dairy animals and thin cattle of beef breeding is not sold over the block. Also, if the moneyed buyer insists on buying only the top grade of meat, namely "U. S. Prime" or its equivalent, it must be remembered that only one-tenth of one per cent of the slaughter cattle will produce carcasses of this top grade. This means that only one animal out of each thousand slaughtered will produce the very top grade of meat. To be sure, the lower grades are equally wholesome, but they are simply graded down because the carcass is somewhat deficient in conformation, finish, or quality.

Thus when the national income is exceedingly high, there is a demand for the choicest but limited cuts of meat from the very top but limited grades. This is certain to make for high prices, for the supply of such cuts is limited, but the demand is great. Under these conditions, if prices did not move up to balance the supply with demand, there would be a marked shortage of the desired cuts at the retail counter.

It must also be remembered that meats must compete with other food products for the consumer's dollar. In addition to preference, therefore, relative prices are an important factor in determining food selection.

Meat must also compete with certain nonfood items, for there are people who would literally go hungry in order to be able to spend their money for other purposes. On the average, prior to World War II, consumers spent about 5 to 6 per cent of their total income for meat. In recent years, the percentage has been larger, fluctuating between 6 and 7 per cent.

WORLD AND U. S. MEAT PRODUCTION

The 1947 meat production for the principal livestock countries of the world, exclusive of the Far East, reached 65.9 billion pounds. In Europe, meat output in 1947 was generally below prewar levels. In general, the meat-surplus-producing countries are the newer countries and those that are more sparsely settled.

The United States production of meat (total and by kinds) and lard from 1941 to 1949, is shown in Table 17.

The United States production of meat during the five years of 1945-1949, inclusive, averaged 22,645,000,000 pounds on a dressed meat basis. This represents a decrease from the all-time high production of 25,178,000,000 pounds during the war year of 1944, but it is still substantially above the 1941 production of 19½ billion pounds.

TABLE 17

UNITED STATES PRODUCTION OF MEAT AND LARD FROM 1941 TO 1949, INCLUDING MEAT DRESSED ON FARMS OR BY LOCAL RETAILERS[1]
(in millions of pounds)

Year	All meats, excluding lard	Beef	Veal	Lamb and mutton	Pork excluding lard	Lard
1941	19,569	8,082	1,036	923	9,528	2,228
1942	21,912	8,843	1,151	1,042	10,876	2,401
1943	24,482	8,571	1,167	1,104	13,640	2,865
1944	25,178	9,112	1,738	1,024	13,304	3,054
1945	23,687	10,275	1,661	1,054	10,697	2,066
1946	22,956	9,373	1,440	970	11,173	2,138
1947	23,430	10,428	1,559	802	10,601	2,426
1948	21,446	9,079	1,412	750	10,205	2,356
1949	21,710	9,448	1,322	607	10,333	2,552

[1]Livestock Market News Statistics and Related Data, 1949, U. S. Dept. of Agri., August, 1950, p. 74.

Table 18 shows the number of animals of each of the respective classes slaughtered in the United States in the year 1947 and the proportions of these animals slaughtered in federally inspected plants, nonfederally inspected plants, and farm slaughter.

TABLE 18

UNITED STATES MEAT SLAUGHTERING (FEDERALLY AND NONFEDERALLY INSPECTED AND FARM SLAUGHTER) BY CLASSES OF ANIMALS, 1947[1]

Federal, non-federal or farm slaughter	Cattle (1000 head)	Hogs (1000 head)	Sheep and lambs (1000 head)
Federally inspected	15,521	49,116	16,667
Other wholesale and retail	6,009	12,813	1,540
Farm	860	12,781	559
Total	22,393	74,710	18,766

[1]*Agricultural Statistics*, U. S. Dept. of Agri., 1949, pp. 356, 368 and 384.

PER CAPITA MEAT CONSUMPTION IN VARIOUS COUNTRIES

In general, consumption of meat is higher in new or frontier-type countries that are sparsely populated than in the older and more densely populated regions of the world. In many of the latter areas, insufficient grain is produced to support the human population when consumed directly. This eliminates any possibility of keeping animals, except as scavengers. Certainly, when it is a choice between the luxury of meat and animal by-products or starvation, people will elect to accept a lower standard of living

nd go on a grain diet. In addition to the available meat supply, ood habits and religious restrictions affect the amount of meat onsumed.

As nearly as can be estimated, approximately 63.6 billion ounds of meat were consumed in the meat-eating countries of he world in 1947. Table 19 gives a summary of per capita meat onsumption in several countries of interest:

TABLE 19

PER CAPITA MEAT CONSUMPTION IN VARIOUS COUNTRIES

Country	1947 per capita consumption
New Zealand	262
Argentina	235
Australia	196
United States	155
British Isles	102
Sweden	96
Greece	26

Although the United States is an important meat-eating ountry, three other countries consumed more meat per capita: New Zealand, Argentina, and Australia. All three of these coun-ries possess vast expanses of grasslands, and they are sparsely opulated.

ER CAPITA MEAT CONSUMPTION N THE UNITED STATES

Although comprising less than 6 per cent of the world's opulation, the people of the United States eat about one-fourth f the total world production of beef and pork. The amount of eat consumed in this country varies from year to year. In 1949,

TABLE 20

UNITED STATES PER CAPITA CONSUMPTION OF MEAT (BY KINDS) AND LARD FOR 1949[1]

ype of meat	1949 annual per capita consumption, pounds
eef	63.4
eal	8.7
amb and mutton	4.1
ork (excluding lard)	67.6
Total meat	143.8
ard	12.8

[1] *Livestock Market News Statistics and Related Data, 1949*, U. S. Dept. Agri., August, 1950, p. 74.

the average per capita meat consumption, exclusive of lard, was 143.8 pounds, with 12.8 pounds of lard in addition. That was about 20 pounds per person more than was consumed in the pre-war period, 1935-39. Under ordinary circumstances, meat provides 25 per cent of the total protein and 15 per cent of the energy of the national diet. In 1949, when the per capita civilian consumption of meats, exclusive of lard, totaled 143.8 pounds, the distribution of types of meats was as shown in table 20.

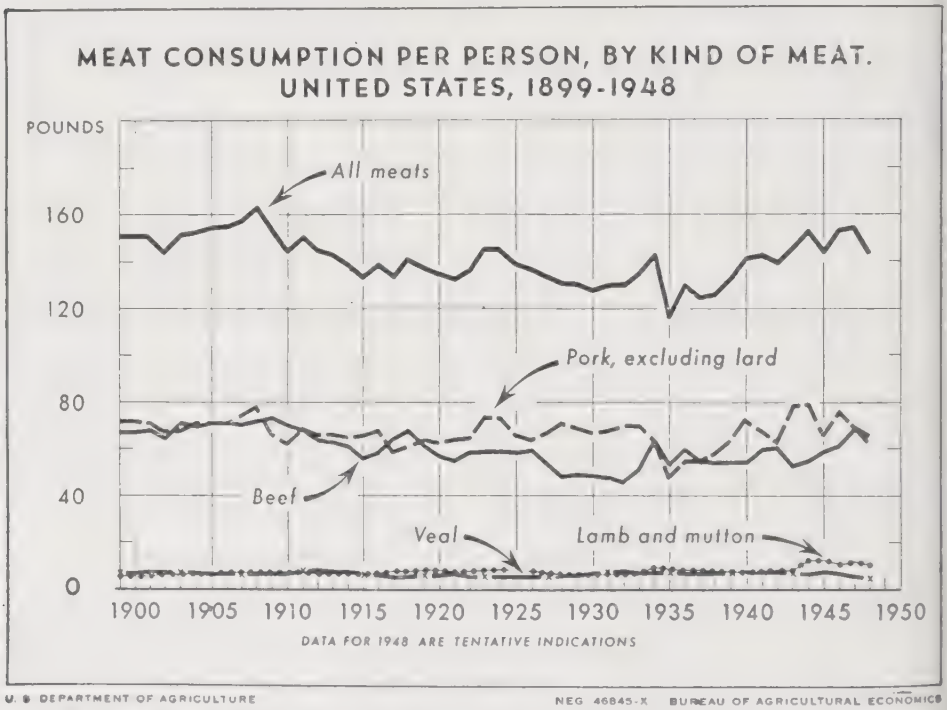


Fig. 110. Per capita meat consumption in the United States, by kind of meat, 1899-1948. As noted, the amount of meat consumed in this country varies from year to year. Generally speaking, the average American consumes more pork than any other kind of meat. Although the United States is an important meat-eating country, three other countries consume more meat per capita: New Zealand, Argentina, and Australia. (Courtesy U.S.D.A., Bureau of Agricultural Economics.)

During the war years, the American servicemen received about 300 pounds of meat per capita, or more than twice the amount eaten by civilians at home during this same period. The Office of Surgeon General of the Army issued figures showing that meat supplied 43.4 per cent of the protein in the soldier's daily diet, 36.5 per cent of the iron, 35.4 per cent of the riboflavin, 33.4 per cent of the thiamin, and 31.0 per cent of the phosphorus. In addition, meat was ranked as the number-one morale food for the armed forces.

For the most part, meat consumption in this country is on a omestic basis, with only negligible amounts being either import-d or exported. Although cured meats furnish somewhat of a eserve supply—with more meats going into cure during times f meat surpluses—our meat consumption generally is up, when ivestock production is high. Also, when good crops are produced nd feed prices are favorable, market animals are fed to heavier veights. On the other hand, when feed-livestock ratios are un-avorable, breeding operations are curtailed, and animals are narketed at lighter weights. But during the latter periods, num-ers are liquidated, thus tending to keep the meat supply fairly table.

MEAT EXPORTS AND IMPORTS

The United States export trade in meats has always con-isted chiefly of pork and lard. Beef, veal, and lamb are exported n negligible quantities. Until the outbreak of World War II, this ountry experienced a steady decline in meat and lard exports. The high year for beef exports was 1918; for pork exports, 1919; nd for lard exports, 1923. Although American-produced pork roducts were exported to as many as fifty different countries n a normal year, the United Kingdom was the leading customer.

The amount of meat exported from this country is depend-nt upon: (1) the volume of hogs slaughtered in the United tates, (2) the volume of meat production abroad, and (3) the elative vigor of international trade, especially as affected by uying power and trade restrictions.

The leading meat-exporting countries competing for the orld trade in meats are: *for beef exports*, Argentina, Australia, Jruguay, Brazil, and New Zealand; *for lamb*, New Zealand, ustralia, and Argentina; and *for pork and lard*, Canada, Ire-nd, and the United States.

During the period of World War II, 1941-1945 inclusive, merican-produced meats were used extensively in the diets of ur allies. In this five-year period, a total of nearly eight billion ounds of meat was shipped to our allies under lend-lease com-itments. In comparison with a like pre-war period, 1936-40, otal meat exports (excluding lard) were increased by 685 per ent during World War II. In 1947, meat exports only totaled 00 million pounds, merely 2 per cent of the total production. his represents a sharp decline from the 2,300 million pounds xported in 1946.

During the first half of 1947, lard exports accounted for 17 per cent of the total production, compared with 21 per cent during 1940-45, and 10 per cent during 1935-39. It is doubtful that the high war and early postwar demand for lard will continue. In fact, it is expected that export outlets for meat and lard will be unimportant to the industry in the years immediately ahead.

United States meat imports are also negligible. In any given year, meat imports would have supplied our national ration for less than a week. In 1937, which was a high year for meat im-

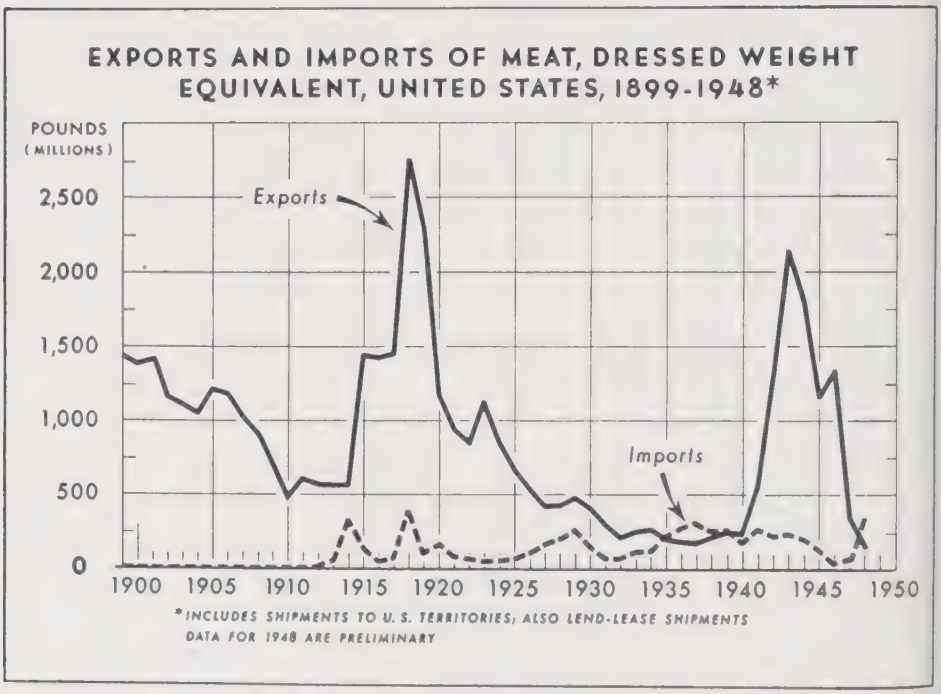


Fig. 111. Meat exports and imports. Except for the period of World War II, little meat was exported from this country following World War I. United States meat imports are also negligible. (Courtesy, U.S.D.A., Bureau of Agricultural Economics.)

ports, only about 170 million pounds of meat was brought into the United States, or less than 1½ pounds per capita. Prior to World War II, a limited amount of canned beef (mostly canned corn beef) was obtained from South America, fresh pork and beef from Canada, and canned hams from Poland. Because of restrictions designed to prevent the introduction of foot-and-mouth disease, fresh beef is not imported to the United States from South America.

In addition to actual meat imports, a small number of potential slaughter cattle (usually stockers and feeders) are normally

brought into this country from Mexico and Canada. During the period of 1940-1944, prior to the 1946 outbreak of foot-and mouth disease, an average of 453,000 head of cattle, mostly feeder animals under 700 pounds in weight, were brought in each year from Mexico. During the period 1935-39, an average of 229,000 head of cattle were imported from Canada. Effective in August, 1948, wartime Canadian restrictions were again lifted, thus allowing these importations to be resumed.

TRENDS IN PER CAPITA CONSUMPTION OF MEAT AND OTHER FOODS

Figure 112 shows the trends in per capita consumption of meat and other foods, by groups. As will be noted, the consumption of grain products and potatoes has gone steadily downward,

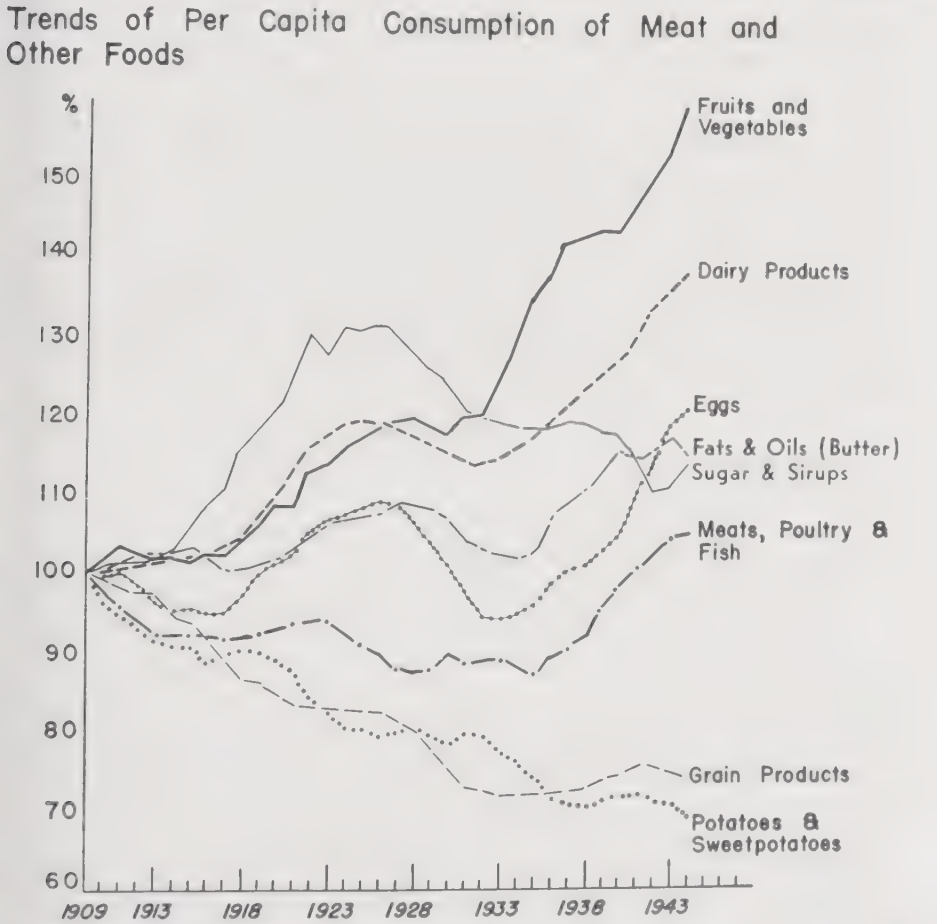


Fig. 112. Trends in per capita consumption of meat and other foods, with 1909 to 1913=100. Until recently, the long-time trend in meat consumption was downward. (Figures obtained from U. S. Department of Agriculture and reproduced by American Meat Institute.)

whereas the per capita consumption of fruits and vegetables and dairy products has increased. Until recently, the long-time trend in meat consumption was downward.

The selection of foods is based on taste preference and relative prices, with different foods competing with each other for a place in the consumer's diet. In prosperous times and with increased buying power, the preferred foods increase in demand and price. Because grain products and potatoes are not luxury foods, their per capita consumption is little affected by buying power.



Fig. 113. Indians drying and smoking venison. (Photo from a water color original by Ernest Smith. Owned by the Rochester Museum of Arts and Sciences.)

MEAT PRESERVATION

From time immemorial, one of man's major food problems has been that of preserving meats over a period of time and in a condition suitable as a food. Fundamentally, meat preservation is a matter of controlling putrefactive bacterial action. Various methods of preserving meats have been practiced through the ages, the most common of which are: (1) drying, (2) smoking, (3) salting, (4) freezing, (5) canning, and (6) sausages.

In this country, meat curing is largely confined to pork, primarily because of the keeping qualities and palatability of cured-pork products. Considerable beef is dried or corned and some lamb and veal are cured, but none of these is of such great importance as cured pork.

rying or "Jerked Beef"

Meat drying appears to have originated in the arid countries, robably in northern Asia. The Spaniards who followed Columbus North America found the native Indians using dried meat. ith a plentiful supply of buffalo, they merely used the eye uscle of the loin and rib and the tenderloin. These muscles ere cut into long, thin, flat strips which were hung to dry in ees, on poles, or in the tops of huts or tepees out of the reach dogs. Today, beef is still dried in many of the more remote



Fig. 114. Smoking meats in early colonial days. This method of preving meats is very old. Smoking is still a common practice in the homeing of pork, and modern meat packers smoke many of their products. ourtesy, Swift and Co.)

parts of the world, including many of those areas of South America that are not served by packing plants. Beef thus cured, smoked, and dried is known as dried beef or "jerked beef."

Smoking

No doubt, smoking of meats came into use through the drying method. As the drying process was hastened by the heat from fires, it was discovered that the smoke overcame certain objectionable qualities and imparted desirable flavor to the meat. Smoking meats was common practice among the ancient Egyptians, and the native Indian was already preserving meats by this method when Columbus discovered America. Hickory, oak, and maple are the favorite smoke woods, although the primitive Indians used semi-dry grass, sage, and various aromatic seeds and plants. Smoking is a common practice in the home-curing of pork, and most packer dry-cured and sweet-pickled cured pork cuts are smoked, as well as many items of sausage.

Salting

Although salting is the chief method of curing, sugar and spices are sometimes added for flavor. There are three methods of preserving meat by the use of salt: (1) dry-salting, (2) dry-cure, and (3) sweet-pickle.

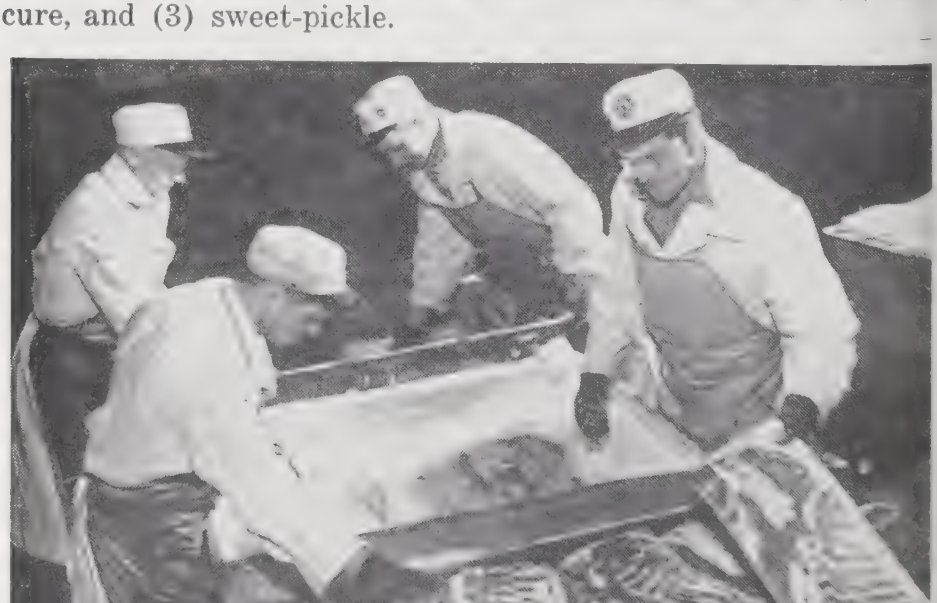


Fig. 115. Dry-salting bacon for curing. The cuts are thoroughly rubbed with salt, after which they are piled closely in layers and resalted at intervals. Salting, which is still the chief method of curing meats, has been practiced since the fifth century B.C., and possibly longer. (Courtesy, American Meat Institute.)

)RY SALTING:

Dry-salting of meats has been practiced since the fifth century 3. C., and possibly longer. Just how the method originated is ot definitely known, but it is quite likely that it was purely acci- ental. It is reported, however, that the salted meats of the an- ients were very unevenly cured and objectionably dry and salty. At the present time, the meat packing industry uses the dry-salt



Fig. 116. Hams in dry cure (or dry-sugar cure). After the curing for- ula is added, most packers allow 15 to 45 days to cure a ham and 17 to 0 days to cure a bacon. Most dry-cured pork is smoked following the for- ula treatment. (Courtesy, Meat Magazine.)

ethod of curing some meats intended for export. Some backs, ides, shoulders, and other cuts of pork, primarily intended for se in the South, are also dry salted. Dry-salted, heavy fat backs re also popular in New England and in the baked-bean industry. n curing, the cuts are thoroughly rubbed with salt, after which hey are piled closely in layers and resalted at intervals. The reservation of beef by the use of salt is termed "corning."

Dry-salting was formerly the most common method of pre- erving farm pork, but, for the most part, it has now been re- laced by the dry-cure method.

DRY CURE (OR DRY-SUGAR CURE):

Dry-cure (or dry-sugar cure) produces more palatable and attractive products than can be secured by dry-salting alone. In this method, a curing formula is used, consisting of different quantities of salt, sugar, and sodium nitrate. This method of curing is considered the safest for farmers and operators who do not have refrigerated curing rooms. Although the formula is usually somewhat different, both pork and beef may be cured by this method, the latter being known as "corned beef." Dry-curing has been increasing in favor in the packing industry in recent years.

Most dry-cured pork is smoked following the formula treatment. Although he may vary the treatment, the packer usually allows fifteen to forty-five days to cure a ham and seventeen to thirty days to cure bacon, prior to smoking.

The famous Virginia-cured hams and Smithfield hams are cured by a special dry-cure, which usually involves liberal quantities of pepper and special smoking and drying in addition to the formula curing ingredients. It is estimated that in curing, in smoking, and in drying and aging—operations requiring 6 to 8 months—Smithfield hams are handled 84 times and shrink 25 per cent from their green weight.



Fig. 117. Barreled products in sweet-pickle cure in the cellar of a meat packing plant. Both pork and beef are preserved by this method. (Courtesy, Meat Magazine.)

By a quarter-century old act of the Virginia state legislature, a ham labeled "Genuine Smithfield" must be processed in Smithfield, Virginia, and come from a hog raised in the peanut belt of Virginia and North Carolina.

THE SWEET-PICKLE CURE:

The sweet-pickle cure is produced when the preservative consists of salt, sugar, sodium nitrate, and water. Although many of the formulae for making a sweet-pickle are jealously guarded, the basic ingredients are universally the same. The main difference exists in the proportions. As with the dry cure, both pork and beef may be preserved by this method. The cured product of the latter is known as corned beef.

Freezing

Freezing of meats was a natural development in the temperate and arctic regions. With the growth of artificial refrigeration, the practice has been widely adopted. Bacteria become relatively inactive at low temperatures and entirely powerless in substances that are frozen.

Most beef and lamb is sold fresh and is chilled but not frozen until it is retailed. Commercial meat coolers are usually held at 32° to 38° F. Chilled meats can be preserved at this temperature for a period of about six weeks, with variation according to: (1) kind of meat, (2) quality of meat, (3) degree of finish or fatness, and (4) humidity of the chill room. As has already been indicated, the development of artificial refrigeration around 1880 revolutionized the meat packing industry. At that time, the packing industry developed into a year-round proposition, instead of merely a winter operation. Beef and lamb came into extensive use; and the packing industry moved near the areas of production after finding it more efficient to ship meats in refrigerated cars than to ship animals on foot.

Frozen meats can be held from six months to a year or even longer. The length of time varies with the kind and initial quality of the product, the care in processing, and the storage temperature. Cold-storage locker plants and home-freezer units now make it possible to have frozen meats on a family basis. Commercial sources of frozen meats and other foods also are available in most cities. The temperature of a sharp-freezing room usually ranges from 0° to 20° F. below zero; whereas the preferable temperature of the locker room is somewhere between zero and 10° F.

A cold-storage locker plant at Chico, California, first made cold-storage space available to farmers for meat storage in 1908. Similar cold-storage arrangements were opened at Crete, Nebraska, in 1910; Centralia, Washington, in 1917; Sioux City, Iowa, in 1920; and Walla Walla, Washington, in 1927. Today, many hundreds of such plants are located throughout the United States. Moreover, home-freezer units are increasing in importance; and, largely because of the extension of rural electrification, farmers and ranchers are installing these conveniences. For example, it is reported that three out of each four farm families in the state of Iowa now have electricity. According to estimates reported by the U. S. Department of Agriculture, the number of frozen-food locker plants in this country reached a total of 9,529 in July, 1947. This represents an increase of 1,504, or 19 per cent, over the previous year.

Canning

Arthur Libby introduced canned corn beef in 1874, and this was followed by many other palatable canned meat preparations. Until refrigeration became widely available, a considerable quantity of beef was preserved by canning. Even today, many meats are handled in this manner, both commercially and in the home.

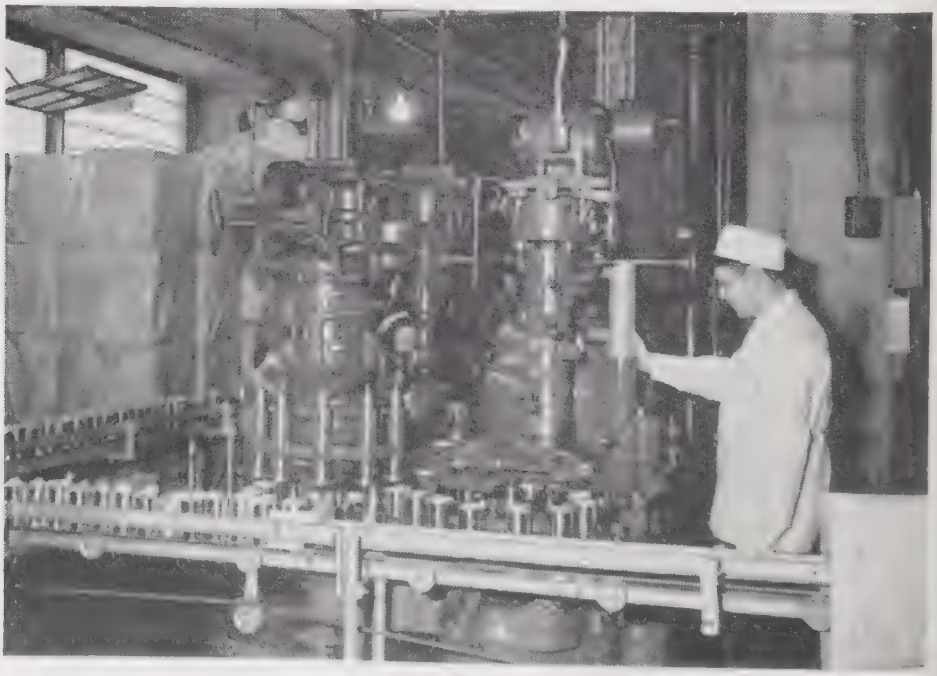


Fig. 118. Canning meats. This popular method of meat preservation was first initiated by Arthur Libby in 1874. (Courtesy, Meat Magazine.)

Sausage

Broadly speaking, sausage is cured, ground meats. It represents both a method of meat preparation, and—except for fresh sausage—a means of meat preservation. The making of sausage antedates recorded history. It emerged as a common food thousands of years before the time of Christ. Sausage was known in the days of Confucius, the Chinese sage; and the Greek poet, Homer, mentioned it in the *Odyssey*.

It is estimated that one out of every eight pounds of meat produced in the United States is prepared and consumed as sausage, with the proportions about as follows: frankfurters, 32 per cent; bologna, 24 per cent; fresh pork sausage, 12 per cent; dry sausage, 6 per cent; all others, 26 per cent. Although all kinds of meats are so prepared, the use of pork predominates. The large meat packing plants manufacture 150 or more different varieties of sausage, consisting of fresh, fresh-smoked, cooked, dry, and semi-dry products. The great variety of sausage available today is due to the fact that each nation originally made sausage to suit its particular taste and according to the limitations of climate and seasoning material. The foreign origin of many sausages is seen in their names.

Sausage consists mainly of trimmings from the cutting rooms and the lower-grade carcasses and cuts that are not satisfactory to sell over the block. In some varieties of popular-priced sausages, other products—such as spices, dried milk, and cereals—are blended with the meat to secure the desired flavor and consistency and, in some instances, to lower the cost. The most commonly used cereals are rice, wheat, corn, or potato flours. In federally inspected plants, the cereals in manufactured sausages must be limited to 3½ per cent by weight; otherwise the sausage must be labeled imitation. A few special sausage products, such as chili con carne, scrapple, and souse (which must be labeled with these names) can contain cereal in excess of 3½ per cent of the total weight.

The average large meat packing plant produces four main classes of sausage, using pork alone or pork combined with beef: (1) domestic sausage, (2) dry sausage, (3) fancy sausage, and (4) sausage specialties.

DOMESTIC SAUSAGE:

Smoked sausage (or domestic sausage) is made from beef or pork, or both. The finely chopped product is mixed with spices, stuffed into casings, subjected to hardwood smoke, and cooked.

Domestic sausages include frankfurters, bologna, cooked thuringer, mettwurst, etc. The traditional American "hot dog" consists of approximately half beef and half pork, plus dried milk and some less costly materials, all of which is seasoned, stuffed into casings, cooked, and smoked.

DRY SAUSAGE:

Dry sausage is often called "summer" sausage because it was formerly sold mainly during the summer months. It is made of pork and beef, which is chopped, seasoned, cured, and stuffed into casings. Some varieties are smoked and dried, whereas other varieties are dried without smoking. For the most part, dry sausage is eaten without cooking. This type of sausage is especially popular among people of foreign birth. As a matter of fact, many of these sausages are of European origin, and bear the name of the province, city, or town in which they originated. Some examples of dry sausages are: Genoa salami, gothaer cervelat, goettinger cervelat, pepperoni, thuringer cervelat, mortedella, and landgaeger.

FANCY SAUSAGE:

Fresh-pork sausage is made from selected fresh-pork cuts, which are chopped fine and seasoned with salt and pepper and usually sage. Generally, this product is placed in links of different sizes, although it may be sold as bulk pork sausage or in patties.



Fig. 119. Some of the many different varieties of sausage. Some are fresh; others are dry, smoked, or cooked. Sausage represents both a method of meat preparation, and—except for fresh sausage—a means of meat preservation. The making of sausage antedates recorded history. (Courtesy, National Live Stock and Meat Board.)

SAUSAGE SPECIALTIES:

Sausage specialties (or cooked specialties) hardly resemble the products of the first three groups, but they are generally classified as sausage because they are produced in the sausage departments of meat packing companies. These include such products as meat loaf, minced and pressed ham, jellied meat, corned beef, chili con carne, head cheese, and luncheon meats. These products are ready to serve without further cooking.

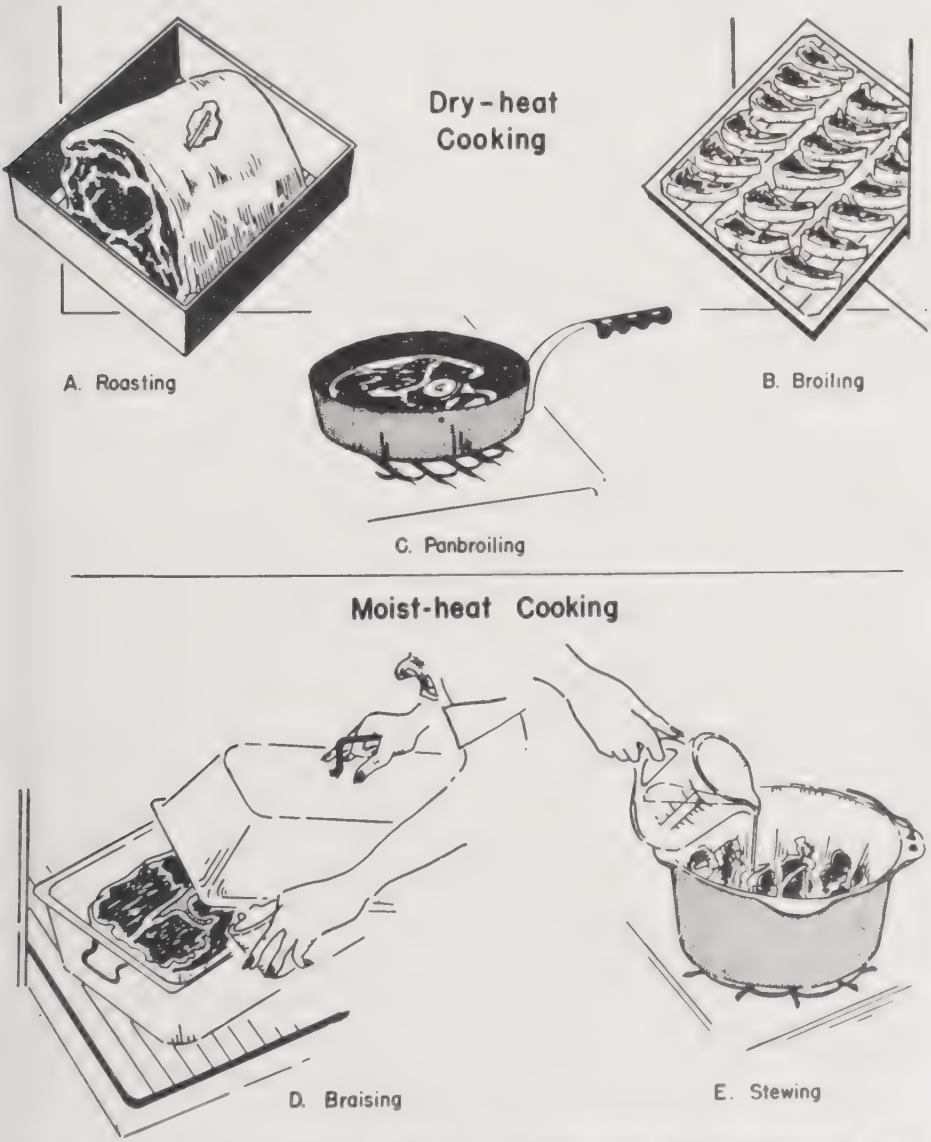


Fig. 120. Common methods of meat cookery: *Dry-heat cooking*: A, roasting; B, broiling; and C, panbroiling; *moist-heat cooking*: D, braising; and E, stewing (cooking in water). (Drawing by R. F. Johnson.)

METHODS OF MEAT COOKERY

The method used in meat cookery depends on the nature of the cut to which it is applied. In general, the types of meat cookery may be summarized as follows:

Dry Heat Cooking

Dry-heat cooking is used in preparing the more tender cuts, those that contain little connective tissue. This method of cooking consists of surrounding the meat by dry air in the oven or under the broiler. The common methods of cooking by dry heat are: (a) roasting, (b) broiling, and (c) panbroiling.

Moist Heat Cooking

Moist-heat cooking is generally used in preparing the less-tender cuts, those containing more connective tissues that requires moist heat to soften it and make it tender. In this type of cooking, the meat is surrounded by hot liquid or by steam. The common methods of moist-heat cooking are: (a) braising, and (b) cooking in water (called "stewing" when small pieces of meat are so cooked).

PACKING HOUSE BY-PRODUCTS FROM SLAUGHTER

The meat or flesh of animals is the primary object of slaughtering. The numerous other products are obtained incidentally. Thus, all products other than the carcass meat are designated as by-products, even though many of them are wholesome and highly nutritious articles of the human diet. Yet it must be realized that upon slaughter cattle, sheep, and hogs produced in the United States yield an average of 46, 53, and 25 per cent, respectively, of products other than carcass meat. When a meat packer buys a steer, lamb, or hog, he buys far more than the cuts of meat that will eventually be obtained from the carcass.

In the early days of the meat packing industry, the only salvaged by-products were hides, wool, tallow, and tongue. The remainder of the offal was usually carted away and dumped into the river or burned or buried. In some instances, packers even paid for having the offal taken away. In due time, factories for the manufacture of glue, fertilizer, soap, buttons, and numerous other by-products sprang up in the vicinity of the packing plants. Some factories were company-owned, and others were independent industries. Soon much of the former waste material was being converted into materials of value. Today, it is estimated that 12 per cent of packer earnings are derived from by-products. Natu-

rally, the relative value of carcass meat and by-products varies both according to the class of livestock and from year to year. In 1937, it was estimated that packers derived the following percentages of their total income from the sale of by-products of the different classes of slaughter animals: cattle, 15 per cent; lambs, 25 per cent; calves, 24 per cent; and hogs, 4 per cent.[1] As noted, sheep rank first in percentage of return from slaughter by-products, and hogs, last. The high by-product value of sheep is chiefly due to the pelt.

In contrast to the four early-day by-products—hide, wool, tallow, and tongue—modern cattle slaughter alone produces approximately eighty by-products which have a great variety of uses. Although many of the by-products from cattle, sheep and hogs are utilized in a like manner, there are a few special products which are peculiar to the class of animals (e.g, wool and "catgut" from sheep).

The complete utilization of by-products is one of the chief reasons why large packers are able to compete so successfully with local butchers. Were it not for this conversion of waste material into salable form, the price of meat would be much higher than under existing conditions. In fact, under normal conditions, the wholesale value of the carcass is about the same as the cost of the animal on foot. The returns from the sale of by-products cover all operating costs and return a reasonable profit.

Important By-Products From Animal Slaughter

It is not intended that this book should describe all of the one hundred or more by-products obtained from animal slaughter. Rather, only a few of the more important ones will be listed and briefly discussed.

1. **Hides.**—Hides are particularly valuable as a by-product of cattle slaughter. Thus most of the discussion in this section will be especially applicable to cattle hides.

Cattle hides have been used by man since the dawn of time; and leather, particularly cowhide, has held an important place in commerce throughout recorded history. It was an important part of the clothing and armour of ancient and medieval times, and today it has hundreds of industrial uses.

On the average, the hide represents 9 per cent of the total on-foot value of the better-grade heavy steers and as much as

[1]Reported by Swift & Co., Agricultural Research Bulletin No. 10, Nov., 1937.

15 per cent of the live value of low-grade cows. There are two great classes of cattle hides, based on their place of origin: packer hides and country hides. Packer hides are the most valuable of the two because they are more uniform in shape, cure, and handling; much freer from cuts and gashes; and uniformly graded and available in larger lots.

The presence of needlessly large brands lowers the value of the hide. Cattle grubs (ox-warbles) also damage hides. It is estimated that one-third of all cattle hides produced in the United States are damaged by grubs. If there are five or more grub holes in the hide, it is classed as No. 2 and is discounted 1 per cent per pound. Because of the larger throat cut, hides from kosher-killed cattle are less valuable.

The leather from animal hides is used for shoes, harness and saddles, belting, traveling bags, razor strops, footballs, baseball mitts, "sheepskins" for diplomas, sweat bands for hats, gloves, and numerous other leather goods.

2. **Sheep pelts.**—The sheep pelt is by far the most valuable by-product of sheep slaughtering. It usually represents about 14.5 per cent of the total sheep slaughter income. Sheep skins with short wool, ¾ inch or less in length, are usually tanned with the wool on and are used for coats, robes, rugs, felts, slippers, and other articles. Pelts with longer wool are sent to the "pullery." Usually they are temporarily preserved by the addition of salt until the wool is removed. The pulling process consists of applying a depilatory solution (made of sodium sulphide, slaked lime, and water) to the skin side of the pelt and then pulling the wool loose from the skin after the chemical action has loosened the hold of the fibers.

3. **The fats.**—Next to hides and pelts, the fats (not including lard) are the most valuable by-product derived from slaughtering. Products rendered from them are used in the manufacture of oleomargarine, soaps, animal feeds, lubricants, leather dressing, candles, fertilizer, etc.

Oleomargarine, which is perhaps the best known of the products in which rendered animal fat is incorporated, is usually a mixture of vegetable oils and select animal fat.[1] Oleo oil, one of the chief animal fats of this product, is obtained from beef and mutton or lamb. Oleomargarine was first perfected in 1869 by

[1]Oleomargarine is of two kinds: (1) A mixture of 50 to 80 per cent animal fat and 20 to 50 per cent vegetable oil, churned with pasteurized skimmed milk, or (2) 100 per cent vegetable oil, churned with pasteurized skimmed milk.

the Frenchman, Mege, who won a prize offered by Napoleon III for a palatable table fat which would be cheaper than butter, keep better, and be less subject to rancidity.

4. **Variety meats.**—The heart, liver, brains, kidneys, tongue, cheek meat, tail, feet, sweetbreads (thymus and pancreatic glands), and tripe (pickled rumen of cattle and sheep) are sold over the counter as "variety meats" or "fancy meats."

5. **Hair.**—Artist and camel-hair brushes are made from the fine hair on the inside of the ears of cattle. Other hair from cattle and hogs is used in tooth brushes; paint brushes; mattresses; upholstery for furniture, automobiles, and passenger planes; air filters; baseball mitts; parachute seat pads, etc.

6. **The horns and hoofs.**—At one time considered a nuisance horns and hoofs are now converted into napkin rings, goblets, tobacco boxes, knife and umbrella handles, combs, buttons, etc.

7. **Blood.**—The blood is used in the refining of sugar, in making blood sausage and stock feeds; in making buttons, and in making shoe polish, etc.

8. **Meat scraps and muscle tissue.**—After the grease is removed from meat scraps and muscle tissue, they are made into meat-meal or tankage.

9. **Bones.**—The bones and cartilage are converted into stock feed, fertilizer, glue, crochet needles, dice, knife handles, buttons, teething rings, toothbrush handles, and numerous other articles.

10. **Intestines and bladders.**—Intestines and bladders are used as sausage, lard, cheese, snuff, and putty containers. Lamb casings are used in making surgical sutures, strings for various musical instruments, and strings for tennis rackets.

11. **Glands.**—The glands of the body are used in the manufacture of numerous pharmaceutical preparations. These include the pituitary, thyroid, ovary, pancreas, suprarenals, and other glands. Proper preparation of glands requires quick chilling and skillful handling. Moreover, a very large number of glands must be collected in order to obtain any appreciable amount of most of these pharmaceutical products. For example, the glands from more than 100,000 lambs are necessary to produce one pound of adrenalin, a powerful heart stimulant. It takes pancreas glands from 1,500 cattle or 7,500 hogs to produce one precious ounce of insulin, and this is the only source. The carefully prepared pharmaceuticals are prescribed by doctors in treating people afflicted with diabetes, pernicious anemia, and many other diseases and ailments.

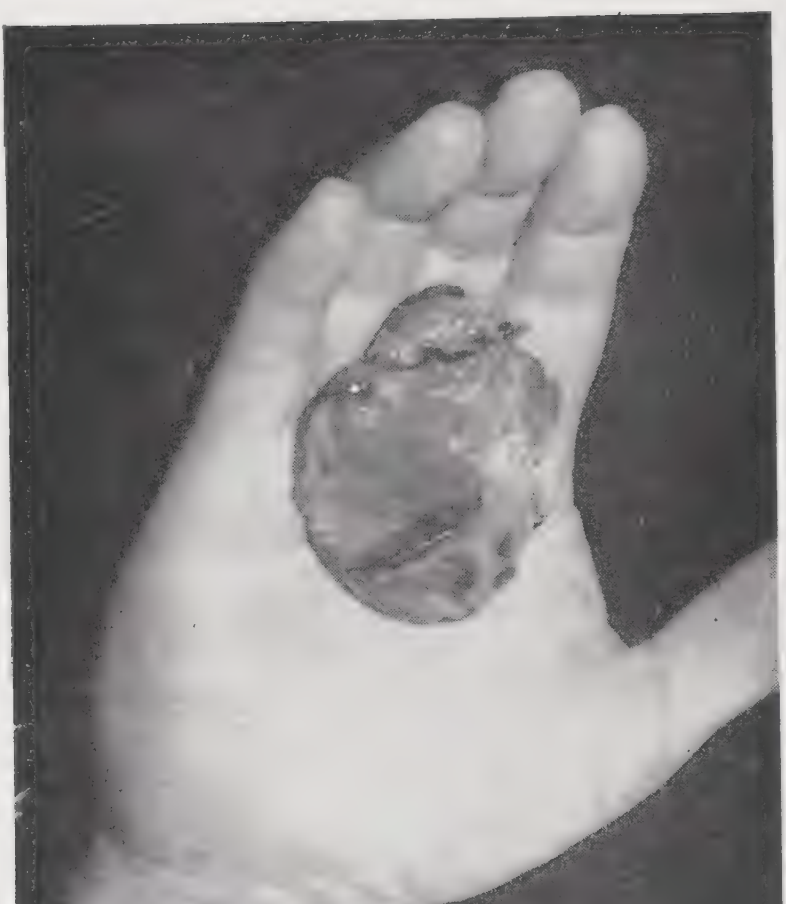


Fig. 121. Pancreas gland from a pig. It takes the pancreas glands from 1,500 cattle or 7,500 hogs to produce one precious ounce of insulin, and this is the only source. Without insulin, many people afflicted with diabetes could not hope to live. (Courtesy, Meat Magazine.)

12. **Collagen.**—The collagen of the connective tissues—sinews, lips, head, knuckles, feet, and bones—is made into glue and gelatin. The most important use for glue is in the wood-working industry. Gelatin is used in baking, ice cream making, capsules for medicine, coating for pills, photography, culture media for bacteria, etc. About 50 per cent of the United States production of gelatin comes from veal.

13. **Contents of the stomach.**—Contents of the stomach are used in making fertilizer.

Thus, in a modern packing plant, there is no waste; not a single element of value is discarded. These by-products benefit the human race in many ways. Moreover, their utilization makes

t possible to slaughter and process beef, lamb, and pork at a much lower cost. But this is not the end of accomplishment! Scientists are continually striving to find new and better uses for packing house by-products in an effort to increase their value.

MEAT RESEARCH OF THE FUTURE

In the future, research in the field of meats can well include greater emphasis on the composition and quality of the product. There is need for information on how the concentration of different soil nutrients and the chemical composition of the feeds produced thereon effect composition of the meat, blood, and bone of farm animals. The meats, nutrition, and animal-breeding investigators need to join forces in an effort to secure marbling and palatibility without the excess fat trim now encountered.

Increased emphasis needs to be given to the more profitable utilization of by-products. Research should also make a critical evaluation of newer methods of merchandising and newer methods of cooking meats. This research should include investigation of selling via self-service and frozen form, and cooking through dielectric heating or electronics. Continued marketing and processing studies need to be made.

CHAPTER VIII

HISTORY AND DEVELOPMENT OF THE BEEF CATTLE INDUSTRY[1]

Cattle are the most important of all the animals domesticated by man, and next to the dog, the most ancient. There are about eight hundred million cattle in the world today.[2]

The word "cattle" seems to have the same origin as "chattle," which means possession. This is a very natural meaning, for, when Rome was in her glory, a man's wealth was often computed in terms of his cattle possessions, a practice which still persists among primitive people in Africa and Asia. That the ownership of cattle implied wealth is further shown by the fact that the earliest known coins bear an ox head; and the Roman word "pecunia" for money (preserved in our adjective "pecuniary") was derived from the Latin word "pecus," meaning cattle. It is also noteworthy that the oldest known treatise on agriculture, written by the Greek poet Hesiod, referred to cattle. Apparently having had some disturbing experiences with young oxen, Hesiod advised: "For draught and yoking together nine-year-old oxen are best because, being past the mischievous and frolicsome age, they are not likely to break the pole and leave the plowing in the middle."

ORIGIN AND DOMESTICATION OF CATTLE

It seems probable that cattle were first domesticated in Europe and Asia during the New Stone Age. In the opinion of most authorities, today's cattle bear the blood of either or both of two ancient ancestors—namely, *Bos taurus* and *Bos indicus*.

[1]The author wishes to express his sincere gratitude to the following nationally known beef cattle authorities who reviewed Chapters VIII through XV: Mr. Alan Rogers, Owner of Walking T Ranch and Former chairman of the Public Relations Committee of the American National Live Stock Association, Ellensburg, Washington; Mr. Robert W. Lazear, Manager, Wyoming Hereford Ranch, Cheyenne, Wyoming; and Professor P. S. Shearer, Head, Department of Animal Husbandry, Iowa State College, Ames, Iowa. The author also feels especially fortunate in having the valued counsel and suggestions of Mr. Karl P. Schmidt, Chief Curator of the Department of Zoology, Chicago Natural History Museum, Chicago, Illinois, who so patiently and thoroughly reviewed all the historical chapters—Chapters VIII, XVI, XXVI, and XXXIII.

[2]1951 preliminary estimate, Office of Foreign Agricultural Relations placed numbers at 806,300,000 head.

Other species or subspecies were frequently listed in early writings, but these are seldom referred to today. Perhaps most, if not all, of these supposedly ancestral species were also descendants of *Bos taurus* or *Bos indicus* or crosses between the two.

Bos Taurus

Bos taurus includes those domestic cattle common to the more temperate zones, and it, in turn, appears to be derived from a mixture of the descendants of the aurochs *(Bos primigenius)* and Celtic shorthorn *(Bos longifrons.)*



Fig. 122. Artist's conception of an Aurochs (*Bos primigenius*) based on historical information. This was the mighty wild ox that was hunted by our ancestors. Most cattle are believed to have descended mainly from the Aurochs. (Drawing by R. F. Johnson.)

Most cattle, including the majority of the breeds found in the United States, are believed to have descended mainly from the massive aurochs (also referred to as "uri," "ur," or "urus"). This was the mighty wild ox that was hunted by our forefathers. It roamed the forests of central Europe down to historic times, finally becoming extinct about the year 1627. About the year 65 B. C., Caesar mentioned this ox in his writings, but it was domesticated long before (perhaps early in the Neolithic Age) and probably south of the Alps or in the Balkans or in Asia Minor. Caesar referred to these animals as "approaching the elephant in size but presenting the figure of a bull." Although this is

somewhat of an exaggeration as to the size of the aurochs, it was a tremendous beast, standing six or seven feet high at the withers, as is proved by complete skeletons found in bogs.

In addition to the aurochs, another progenitor of some of our modern breeds and the earliest known domestic race of cattle was the Celtic shorthorn or Celtic ox. These animals, which have never been found except in the state of domestication, were the only oxen in the British Isles until 500 A. D., when the Anglo-Saxons came bringing with them animals derived from the aurochs of Europe. The Celtic shorthorn was of smaller size than the aurochs and possessed a dished face. It may have had a still different wild ancestor, or may have been an independent domestication from the aurochs.

Bos Indicus

Bos indicus includes those humped cattle common to the tropical countries that belong to the Zebu (or Brahma) group. They are wholly domestic creatures, no wild ancestors having been found since historic times. It has been variously estimated that cattle of this type were first domesticated anywhere from 2100 to 4000 B. C. The zebu is characterized by a hump of fleshy



Fig. 123. Zebu (*Bos indicus*). These wholly domestic animals were the ancestors of the humped cattle common to the tropical countries. (Drawing by R. F. Johnson.)

tissue over the withers (which sometimes weighs as much as forty to fifty pounds), a very large dewlap, large drooping ears, and a voice that is more of a grunt than a low. These peculiar appearing animals seem to have more resistance to certain diseases and parasites and to heat than the descendants of *Bos Taurus*. For this reason, they have been crossed with some of the cattle of Brazil and in the southern states of this country, especially in the region bordering the Gulf of Mexico.

POSITION OF THE OXEN IN THE ZOOLOGICAL SCHEME

Domesticated cattle belong to the family Bovidae, which includes ruminants with hollow horns. Members of this family possess one or more enlargements for food storage along the esophagus, and they chew their cuds. In addition to what we commonly call oxen or cattle, the family Bovidae (and the subfamily Bovinae) includes the true buffalo, the bison, musk-ox, banteng, gaur, gayal, yak, and zebu.

The following outline shows the basic position of the domesticated cow in the zoological scheme:

Kingdom *Animalia:* Animals collectively; the animal kingdom.

Phylum *Chordata:* One of approximately twenty-one phyla of the animal kingdom.

Class *Mammalia:* Mammals or warm-blooded, hairy animals that produce their young alive and suckle them for a variable period on a secretion from the mammary glands.

Order *Artiodactyla:* Even-toed, hoofed mammals.

Family *Bovidae:* Ruminants having polycotyledonary placenta, hollow non-deciduous upbranched horns, and nearly universal presence of a gall bladder.

Genus *Bos:* Ruminant quadrupeds, including wild and domestic cattle, distinguished by a stout body and hollow, curved horns standing out laterally from the skull.

Species *Bos taurus* and *Bos indicus: Bos taurus* includes the ancestors of the European cattle and of the majority of the cattle found in the United States; *Bos indicus* is represented by the humped cattle (zebu) of India and Africa.

USE OF CATTLE IN ANCIENT TIMES

Like other animals, cattle were first hunted and used as a source of food and other materials. As civilization advanced and man turned to tillage of the soil, it is probable that the domestication of cattle was first motivated because of their projected value for draft purposes. Large, well-muscled, powerful beasts were in demand; and any tendency to fatten excessively or to produce more milk than was needed for a calf was considered detrimental rather than desirable. Not all cattle were used for work purposes, however, in the era following their domestication. Instead of planting seeds, some races of people chose a pastoral existence—moving about with their herds as they required new pastures. These nomadic people lived mainly on the products of their herds and flocks.

As populations became more dense, feed became more abundant, and cattle became more plentiful; man became more interested in larger production of meat and milk. The pastoral people adopted a more settled life and began selecting out those animals that possessed the desired qualities—including rapid growth, fat storage, and milk production. Following this transformation, Biblical and other literature referred to milk cows, the stall-fed ox, and the fatted calf.

In contrast with the very great importance of cattle in western Asia and Europe in both ancient and modern times, it is noteworthy that cattle were never very highly valued in China, Japan, or Korea. The people of these countries have never used as much beef, milk, butter, and cheese, as we have. In India, on the other hand, cattle play as important a role as in our western civilization and still retain a great religious significance, which they have lost with us.

CATTLE IN MEDIEVAL FARMING

The best of medieval farms would excite the scorn or contempt of a modern farmer. Except for plowing and carting with oxen, all labor was done by hand. Although the fields were small, several oxen were often yoked to the plow. As few farmers owned many head, it frequently was necessary for an entire village to pool its oxen and plow the fields in common.

Cattle fared badly in these early days. Pastures were overgrazed and winter feed was scarce. In the fall of the year, it was the common practice to kill and salt the carcasses of all those animals not needed for draft or breeding purposes. Prior to

slaughter, aged animals and worn-out oxen were grass fattened, after a fashion. Those that were wintered over were fed largely on straw and the forage they could glean from the fields. Often by spring they were so thin that they could hardly walk.

Very little cow's milk was available, most of it being produced during the grazing season. In fact, more goat's milk than cow's milk was consumed in liquid form. Even in the thirteenth century, when farming methods had improved, one writer indicated that three cows could be expected to produce only three and one-half pounds of butter per week. Most cow's milk was used in cheese making.

LATE MIDDLE-AGES AGRICULTURE OF ENGLAND

During the Middle Ages (500 to 1500) in England, as elsewhere, rotation and improvement of crops and improved breeding methods were not a necessity because virgin soil was abundant and worn-out lands could be deserted for new. Increasing population and the establishment of settlements were later to make improved husbandry a dire necessity.

Examples of the open-field system could still be found in England up to the eighteenth century. However, shortly before 1500, feudalism in England practically ceased to exist, and with its passing the system of enclosures and individual ownership became more prevalent.

IMPROVEMENTS IN ENGLISH CATTLE

English agrarian conditions began to improve during the reign of Elizabeth (1558-1603). No well directed efforts toward the improvement of cattle were made, however, even in England, until late in the eighteenth century. By 1700, from one-third to one-half of the arable land was still cultivated on the open-field system. No individual owner could attempt to improve his flock or his herd when all the cattle of the village grazed together on the same common.

Enclosing started about 1450, but progress in this direction was slow. Animals on the common were often "half-starved," and it was said that five acres of individually owned pasture was worth more than the pasture rights over two hundred and fifty acres of common.

During the eighteenth century, agricultural progress in England quickened. With the coming of field cultivation of clover and artificial grasses, sometime after 1600, and the introduction and cultivation of the turnip somewhat later, a great impetus

was given to agriculture and livestock breeding. Winter feed could now be had, more livestock kept, more manure produced, and better crops grown. Indeed, the progress in stock raising in the eighteenth century cannot be understood apart from the progress made at the same time in general agriculture.

In cattle, size was the main criterion in selection, though power at the yoke and milking quality were not overlooked. Perhaps the ultimate in cattle size was represented by the Lincolnshire ox, standing nineteen hands high and measuring four yards from his face to his rump, a worthy descendant of the aurochs.

BAKEWELL'S IMPROVEMENT OF ENGLISH CATTLE

Robert Bakewell of Dishley (1726 to 1795)—an English farmer of remarkable sagacity and hard, common sense—was the first great improver of cattle in England. His objective was to breed cattle that would yield the greatest quantity of good beef rather than to obtain great size. Bakewell had the imagination to picture the future needs of a growing population in terms of meat and set about creating a low-set, blocky, quick-maturing type of beef cattle. He paid little or no attention to fancy points. Rather, he was intensely practical, and no meat animal met with his favor unless it had the ability to put meat on the back.

Bakewell's efforts with cattle were directed toward the perfection of the English Longhorn, a class of cattle common to the Tees River area. He also contributed greatly to the improvement of the Leicester breed of sheep, and the Shire horse. Success crowned his patient skill and unwearied efforts. But success in breeding was no mere happenstance in Bakewell's program. Careful analysis of his methods reveals that three factors were paramount: (1) a definite goal as evidenced by the joints that he preserved in pickle and the skeletons of the more noted animals that adorned his halls, (2) a breeding system characterized by "breeding the best to the best" regardless of relationship rather than crossing breeds as was the common practice of the time, and (3) a system of proving sires by letting them at fancy prices to his neighbors rather than selling them. Because of Bakewell's methods and success, he has often been referred to as the founder of animal breeding.

Bakewell's experiments were the top news of the day, and his successes, the subject of much comment, both oral and written. The American poet, Emerson, for example, said of the

British farmer, "He created sheep, cows, and horses to order . . . the cow is sacrificed to her bag, the ox, to his sirloin."

By the beginning of the Napoleonic Wars, Bakewell's methods were widely practiced in England, and sheep and cattle were raised more for their flesh than formerly. A new era in livestock improvement was born. As an indication of this change, it is



Fig. 124. Robert Bakewell of Dishley (1726 to 1795), noted agriculturalist and the first great improver of cattle in England. Bakewell also contributed greatly to the improvement of the Leicester breed of sheep, and the Shire horse. (Courtesy, Picture Post Library, London England.)

interesting to observe the change in weights of animals at the famous Smithfield market. In 1710, beeves had averaged 370 pounds, calves 50 pounds, sheep 28 pounds, and lambs 18 pounds; whereas in 1795 they had reached 800, 148, 80, and 50 pounds, respectively. Although the effect of improved agriculture is not to be minimized, the main influence in this transformation can be attributed to Robert Bakewell, whose imagination, initiative, and courage put a firm foundation under improved methods of livestock breeding.

THE GOLDEN PUREBRED ERA

The first emphasis on ancestry occurred in human genealogies, where it is older than recorded history itself. But human pedigrees were emphasized for social purposes, in order to determine the inheritance of property or of rank in a caste system of society, rather than because of any belief in the inheritance of physical and mental qualities. Human genealogies often recorded only the male or female line of descent, as in the early chapters of Genesis, in Icelandic sagas, or in Maori legend.

More than a thousand years ago, the Arabs memorized the genealogies of their horses, tracing the pedigrees in the female line. We have no detailed knowledge of how these pedigrees were used or if they were used at all, as guides in a breeding program.

The use of pedigrees in the modern manner had its beginning in England late in the eighteenth century, and the general formation of breed registry societies began around the middle of the nineteenth century. Soon the improvement that Bakewell and his followers had made in their breeding stock came to be known in other lands. Agriculture was on the move, and the golden age of stockbreeding was at hand. Animals possessing common characteristics were no longer to be confined to a small area and restricted to a few breeders. The number of animal generations in the pedigree increased until no man could remember with certainty all the foundation animals back in the pedigree. To supply this knowledge and to prevent unscrupulous traders from exporting grades or common stock as purebreds, herdbooks were formed. The first herdbook, known as "An Introduction to the General Stud Book," for the Thoroughbred horse appeared in 1791. A private Shorthorn herdbook came out in 1822, and others followed. Men with common interests in the same breed of livestock banded themselves together in breed associations in order to (1) protect the purity of the breed, and (2) promote the spread and value of the breed.

Both in England and on the continent, the breeding of superior cattle engaged the interest of many persons of wealth and high position, even of royalty itself. Albert, the Prince Consort of Queen Victoria, had a magnificent herd of two hundred Shorthorns at the home farm near Windsor Castle, another herd of ninety Herefords at the Flemish Farm two miles distant, and one hundred Devons on the Norfolk Farm. King William of Wurttemberg, as early as 1824, began to import and breed Shorthorns, as did his contemporaries, Nicholas II of Russia, Francis Joseph of Austria, and Louis Philippe of France. Napoleon III was also

heavy buyer of English blooded stock; and if he could not buy he bulls that he desired, he often leased them—particularly was his true of sires from the Booth Herd at Warlaby. The King of ardinia and the King of Spain became interested in stock breeding, crossing English Shorthorns on the long-horned white Tuscan cattle and black Spanish cows.

HE INTRODUCTION OF CATTLE TO AMERICA

Cattle are not native to the Western Hemisphere. They were rst brought into the New World by Christopher Columbus on is second voyage in 1493, and it is thought that they were intended as work animals for the settlers who attempted to found



Fig. 125. Texas longhorn steer. Today, only a few of these hardy animals remain, primarily as a novelty for rodeo and show purposes. (Courtesy, . H. Rose Collection, San Antonio, Texas.)

colony on one of the islands of the West Indies. Cattle were rought to Mexico by Cortez in 1519. Later, in the sixteenth entury, other Spanish cattle were brought to the shores of outheastern United States. The latter animals introduced by ne Spaniards were intended for work and milk purposes in conection with the Christian missions that were established among ne Indians in the New World. This chain of missions extended rom the eastern coast of Mexico up the Rio Grande, thence

across the mountains to the Pacific Coast. Under the favorable feed and climatic conditions common to the area, these hardy Spanish-Longhorn cattle multiplied at a prodigious rate, and many of the animals reverted to a semi-wild state. In 1833, the Spanish priests estimated their total holdings at 424,000 head.[1] The hardy Texas Longhorn, animals of Spanish extraction, were of little commercial value except for their hides. Today, only a few of these animals remain, more as a novelty and for show purposes than for use as meat producers.

The colonists first brought cattle from England in 1609. Other English importations followed, with Governor Edward Winslow bringing a notable importation to the Plymouth Colony in 1623. The latter shipment included three heifers and a bull. Three years later, at a public court, these animals and their progeny—and perhaps some subsequent importations — were appropriated among the Plymouth settlers on the basis of one cow to six persons. It is further reported that three ships carried cattle to the Massachusetts Bay colony in 1625. Other colonists came to the shores of New England bringing with them their oxen from the mother country. As would be expected, the settlers brought along the kind of cattle to which they had been accustomed in the mother country. This made for considerable differences in color, size, and shape of horns, but they all possessed one characteristic in common—the ability to perform work.

For a number of years, there were very few cattle in the United States. Moreover, those animals that the colonists did possess went without winter feed and shelter, and the young suffered the depredations of the wolves. It was difficult enough for the settlers to build houses for themselves, and they could barely raise enough corn in their fields to sustain human life.

Conditions presently changed for the better. The cattle of earlier importations multiplied, new shipments were received, and feed supplies became more abundant. Cambridge, Massachusetts, enjoyed the double distinction of being the seat of Harvard College, the first institution of higher learning in what later came to be the United States, and the most prosperous cattle center in early New England. In order to provide ample grass and browse for the increased cattle population, it was necessary that the animals range some distance from the commons (the town pasture). Thus the tale that the streets of Boston were laid

[1] *Yearbook of Agriculture, 1921*, U. S. Dept. of Agri., 233.

t along former cowpaths is not legend but fact. Usually in eir travels, the cattle were under the supervision of a paid owkeeper" whose chief duty consisted in safely escorting the ttle to and from pasture.

In the village economy, the bull was an animal of consider-le importance. Usually the town fathers selected those animals at they considered as most desirable to retain as sires, and ose citizens who were so fortunate as to own animals of this iber were paid an approved service fee on a per-head basis.



Fig. 126. Oxen pulling a Prairie Schooner (a type of covered wagon). aft oxen were more prized by the colonist than beef. (Courtesy, The tman Archive—from an engraving.)

RAFT OXEN MORE PRIZED BY COLONIST THAN BEEF

From the very beginning, the colonists valued cattle for eir milk, butter, hides, and work; but it appears that little portance was attached to the value of their meat. Beef was nost as much of a by-product of the work oxen in those days are the hides of beef cattle of today. An ox was worked until was old and decrepit, after which he was slaughtered and the ef used as a none-too-welcome diversion from the wild turkey, airie chicken, and venison, which formed the everyday bill of re of the pioneer farmer. So necessary were cattle for draft rposes that, in some of the early-day town meetings, ordi-nces were passed making it a criminal offense to slaughter work oxen before he had passed the useful work age of seven more years. The work requirement led to the breeding of large gged cattle, with long legs, lean though muscular bodies, and

heavy heads and necks. Patient oxen of this type were well adapted for clearing away the forest and turning the sod on the rugged New England hillsides, for hauling the harvested produce over the rough roads to the seaport markets, and for subsisting largely on forages.

AMERICAN INTEREST IN BREEDING

Interest in obtaining well-bred cattle on this side of the Atlantic was a slow one. All through the colonial period, the American farmer let his animals shift for themselves, never providing shelter and rarely feeding them during the winter months. Eventually the lot of the colonist improved, and with it came the desire to secure blooded stock. Fortunately for the United States, the stockman could draw on the improved animals already developed in Britain and on the Continent. Thus it is not surprising to find that the vast majority of the present established breeds of United States beef cattle originated across the Atlantic.

In 1783, three Baltimore gentlemen—Messrs. Patton, Goff, and Ringold—sent to England for the best cattle obtainable. They could not have had any particular breed in mind, for at that time no distinct breed can be said to have existed in England unless it was Bakewell's Longhorn. Hubback, the celebrated foundation Shorthorn bull, was only six years old in 1783, and the fame of the Devon and Hereford was purely local. Other importations followed, and early in the nineteenth century progressive breeders, ever awake to their opportunity, proceeded to make large importations of cattle from England and Scotland. Gradually the native stock was improved.

By 1850, the "battle of the breeds," which for many years had divided English stockmen into rival camps, was transferred across the Atlantic, where it has raged ever since. Except for the occasional emphasis on fancy points to the detriment of utility values, perhaps this breed competition has been a good thing. Undoubtedly, the extensive importations of Shorthorns, Herefords, Ayrshires, and Jerseys in the decades before the Civil War materially improved the quality of American cattle, both for beef and milk production.

In due time, animals of this improved breeding were to make their influence evident on the western range. The Texas Longhorn, descended from the Spanish importations into southeastern United States in the sixteenth century, had furnished the sturdy foundation stock for the range cattle industry. As the product of unnumbered generations in which natural selection and the

urvival of the fittest had held undisputed sway, it is not sur-
rising to find that vitality and the ability to withstand extreme
ardships were the chief virtues of these creatures. Such quali-
es as early maturity, rapidity of growth, and the maximum
evelopment in the high-priced cuts were sadly lacking. Thus
ie use of blooded bulls of English ancestry resulted in a marked
nprovement of the character of the range cattle, though it must
e admitted that no infusion of breeding could have improved
ieir hardiness.

In order to supply the increased range demand for high-class
ulls, a considerable number of purebred herds were established,
specially in the Central States. In addition to selling range bulls,
iese breeders furnished foundation heifers and herd bulls for
her purebred breeders.

FFECT OF THE CIVIL WAR N THE CATTLE INDUSTRY

In 1860, just prior to the Civil War, stock raising was on the
ireshold of becoming one of the nation's leading industries. At
iat time, the aggregate value of United States livestock was
ore than a billion dollars, representing an increase of more than
)0 per cent since 1850. Texas, which had been admitted to the
nion in 1845, was the leading cattle-producing state, and Chi-
igo was the foremost packing center.

With the outbreak of the Civil War, the cattle of the South-
est could no longer reach the normal markets to the north and
ist. Union gunboats patrolled the waterways and the Northern
rmies blocked land transportation. Not even the Confederate
rmies of the South could be used as an outlet. Prices slumped,
id even the best cattle in Texas could be bought for $4 to $6
er head.

In sharp contrast to the conditions in the South and South-
est, the Civil War made for a very prosperous cattle industry
the North. The war-made industrial prosperity of the densely
opulated East and the demands of the Union Army for meat
esulted in a prodigious increase in the consumption of beef.
nflated prices followed, with the result that choice steers were
elling up to $100 per head at the close of hostilities. Many cattle-
en amassed modest fortunes.

At the close of the Civil War, a wide disparity existed be-
veen cattle values in the North and in the Southwest. With the
eturn of normal commerce between the states, this condition
as soon rectified, only to receive another and more serious jolt

with the outbreak of cattle tick fever (Texas fever) in 1867, which a year later, was spread through cattle shipments northward to Illinois and eastward to the Atlantic coast.

THE ABILENE, KANSAS, SHIPPING POINT

Until 1867, the only convenient shipping point for Texas cattle was at Sedalia, Missouri, on the Missouri Pacific Railroad. Unfortunately, at this time, the Missouri Ozarks were heavily infested with bands of robbers and outlaws who often extracted heavy toll from the cattle drovers before passage through the country was permitted. Sometimes these thieves operated under



Fig. 127. Early Abilene, Kansas, shipping point. This eastern Kansas cattle depot on the Kansas Pacific Railroad was established in 1867, for the purpose of providing safe transportation to the east unmolested by the Ozark outlaws. (Courtesy, Swift and Co.)

the guise of sheriffs, constables, and other officials who pretended to be enforcing local laws that prohibited the passage of Texas cattle. In any event, the end result of their handiwork consisted of either (1) beating or otherwise torturing the drovers until they were glad to abandon the herd and flee for their lives, (2) killing the drovers outright, or (3) stampeding the cattle and making away with a large number of them before the drovers could get them under control. Because of these treacherous bands, it soon became necessary for the Texas drovers to travel farther to the west through eastern Kansas.

As a further means of providing safe transportation unmolested by the Ozark outlaws, J. C. McCoy, a prominent Illinois stockman, in 1867, conceived of the idea of establishing a shipping point or cattle depot in eastern Kansas. Abilene was located

h the Kansas Pacific Railroad, which was being built from ansas City to Denver. McCoy is reported to have traversed ersonally the route through eastern Kansas in an effort to select site as far East as possible where cattle could be easily held hile awaiting shipment. Abilene was decided upon because (1) e surrounding country was sparsely populated, and (2) there as an abundance of grass and water upon which cattle could held pending shipment. At the time, Abilene merely consisted twelve small log huts, most of them with dirt floors. Very on, a thriving boom town was born, all of which, for the next w years, appeared to be fully justified as shown by Table 21.

TABLE 21
CATTLE SHIPMENTS FROM ABILENE, KANSAS, 1867-1871

Year	Arrival of cattle at Abilene
1867	35,000
1868	75,000
1869	150,000
1870	300,000
1871	600,000

In 1871, Abilene received 600,000 head of cattle. Both shipng and grazing facilities had been seriously overtaxed. With e arrival of snow, thousands of head of cattle remained unsold, d insufficient feed supplies were available. The severe winter at followed brought appalling losses. With the coming of ring, it was estimated that 250,000 head of cattle had perished thin sight of Abilene. This disaster, coupled with the opening of more plentiful and convenient shipping points, marked the pid decline of Abilene as a shipping center.

HE OUTBREAK OF CATTLE TICK EVER (TEXAS FEVER)

Following the Civil War, the Texas cattle trade had received al encouragement with the establishment of the Abilene, Kans, shipping point in 1867, thus alleviating the hazards of the issouri outlaws. In 1868, however, the Texas cattle trade reived a severe blow. That summer, a group of Chicago cattlemen ipped 40,000 head of cattle from Texas to Tolono, Illinois, in ampaign County, where they were sold to the local farmers part of this shipment was taken over into neighboring Indi-a) for grazing and wintering. About three weeks after the

arrival of this large shipment, the native cattle, occupying the same pastures, began to die in great numbers; whereas the southern cattle—although apparently responsible for spreading the disease—remained in perfect health. The losses were appalling. Farmers became panicky. The cause of the malady was unknown and there was no cure. In despair, many infested herds were marketed, thus spreading the disease eastward as far as the Atlantic Coast. According to reports, in the vicinity of Tolono, Illinois, nearly every native cow died, and in one township only one milk cow survived.

Although the cause of the disease was unknown, the evidence pointed toward the Texas cattle as being the carriers. Strong prejudice against Texas cattle developed. Wild laws and regulations aimed at controlling the movement of Texas cattle and preventing the spread of the disease were enacted by several states. At this point, the price of Texas steers fell, and many cattle held at the Abilene, Kansas, shipping point could not be sold. The Texas cattlemen, however, were not to be outdone. Some of the more enterprising among them conceived of an ingenious advertising campaign. For this purpose, a carload of buffaloes, generously adorned with placards extolling the virtues of Texas cattle and beef, was sent east to St. Louis and Chicago. Simultaneously it was pointed out that Texas cattle were hardy, none of them having contracted the cattle tick fever when exposed to northern winters. The propaganda even included statements to the effect that Texas cattle possessed superior carcasses because of the greater tenderness and better distribution of fat. Soon the pendulum swung back, with the result that Texas cattle became very popular, even commanding a premium over comparable animals native to the North or East.

THE FAR WESTERN EXPANSION OF THE CATTLE INDUSTRY

From the very beginning, cattle raising on a large scale was primarily a frontier activity. As the population of eastern United States became more dense, the stock raising industry moved farther inland. The great westward push came in the eighteenth century. By 1800, the center of the cow country was west of the Alleghenies, in Ohio and Kentucky; in 1860, it was in Illinois and Missouri; and by the 1880's, it was in the Great Plains. The ranches and cowboys of the far West were the counterpart of the New England commons and cowdrivers of the seventeenth and eighteenth centuries.

The western range was recognized as one of the greatest e countries that the world had ever known. Plenty of water unlimited grazing area were free to all comers, and the mar- appeared to be unlimited. Fantastic stories of the fabulous th to be made from cattle ranching caused a rush comparable at of the gold diggers of 1849. All went well until the severe er of 1886. It was the type of winter that is the bane of the emen's existence. Then, but all too late, it was realized that nany cattle had been kept and too little attention had been n to storing up winter feed supplies. The inevitable hap- d. With the melting of the snow in the spring of 1887, thou- s of cattle skeletons lay weathering on the western range, a reminder of overstocking and inadequate feed supplies. y ranchers went broke, and the cattle industry of the West red a crippling blow that plagued it for the next two decades. of this disaster, however, the rancher learned the never-to- rgotten lessons of (1) avoiding overexpansion and too-close ing, and (2) the necessity of an adequate winter feed supply.

WTH OF THE UNITED STATES CATTLE INDUSTRY

Figure 128 shows the growth of the United States cattle stry since 1867, the period following the Civil War. The p designated as "milk cows" includes all cows and heifers

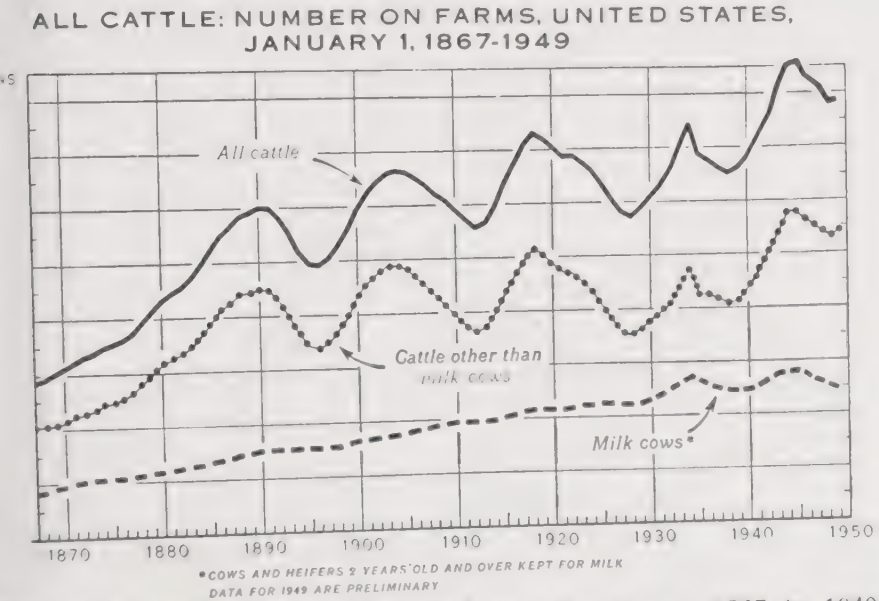


Fig. 128. Cattle on United States farms, January 1, 1867 to 1949. ough beef cattle numbers have increased somewhat, the increases have been as great as those of milk cows nor have they kept pace with in- ses in human population. (Courtesy, U.S.D.A., Bureau of Agricultural nomics.)

two years old and over kept for milk; whereas the curve show "all cattle" embraces milk cows and all other cattle combin As can be observed, milk cows have shown a steady increa with very little in the way of either sharp increases or decreas Although beef cattle numbers have increased somewhat, t increases have not been as great as those of milk cows nor ha they kept pace with increases in human population. It is intere ing to note, however, that the per capita beef consumption h not changed materially, primarily because of the increased p ductive rate of the cattle—the marketing of cattle as baby bee or at slightly older ages instead of as three- to five-year- steers.

BEEF CATTLE IN WORLD WAR II

During the five war years of 1941 to 1945, cattle other th milk cows were increased to an average of 38,489,000 head comparison with an annual average of 31,261,000 head during t five prewar years of 1936 to 1940—an increase of 23.1 per ce But this was not the whole story! Animals received better ca there was marked improvement in livestock feeding; more ne born animals were saved; more attention was given to sanitati disease prevention, and parasite control; animals were more a quately housed; waste resulting from the death and crippling animals in transit was decreased; and other improved mana ment factors received attention as never before.

CHAPTER IX

DISTRIBUTION, ADAPTATION, AND THE FUTURE OF THE BEEF CATTLE INDUSTRY

It is important that producers be well informed concerning orldwide beef production in order to know which countries are tential competitors. Like the price of all commodities in a free mmerce, the price of beef is determined chiefly by supply and mand—that is, by the demand existing in those countries that not produce enough to meet their domestic needs and by the pply which can be spared by those nations producing a surplus.

ORLD DISTRIBUTION OF CATTLE

The production of beef cattle is worldwide. In 1948, there is an estimated total of 751.4 million cattle in the world. Table gives the size and density of cattle population of important ttle-producing countries of the world. During the five-year pre- ar period, the United States exported an annual average of 53.1 llion pounds of beef; whereas during the war years, 1941 to 45, this was increased to an average of 147.8 million pounds



Fig. 129. World distribution of cattle, 1947. Cattlemen should be well formed concerning world-wide beef production in order to know which untries are potential competitors. (Courtesy, U.S.D.A., Office of Foreign gricultural Relations.)

per year, an increase of 178.3 per cent.[1] For the most part, the exports during the war consisted of lend-lease shipments to our fighting allies. Despite the increased beef exports during the war years, we have at intervals continued to import small quantities of canned beef from South America. Thus the beef industry of the United States is essentially on a "home basis."

TABLE 22

SIZE AND DENSITY OF CATTLE POPULATION OF TEN LEADING CATTLE-PRODUCING COUNTRIES OF THE WORLD, BY RANK

Country	No. of cattle[1] (thou.)	When esti-mated[1]	Human popula-tion[2] (thou.	Cattle per capita	Area[2] (thou.) (sq. mi.)	Cattle per sq. mi.
India	205,000	1945	365,900[3]	0.56	1,575[3]	130.2
United States	78,126	1948	142,656	0.55	3,620	21.6
Russia	46,800	1947	182,364	0.26	9,442	5.0
Brazil	46,000	1948	48,000	0.96	3,300	13.9
Argentina	41,268	1947	16,000	2.58	1,113	37.1
China	22,800	1947	491,000	0.05	4,457	5.1
France	15,125	1948	40,830	0.37	213	71.0
Columbia	13,902	1948	9,883	1.41	402	34.6
Australia	13,785	1948	7,581	1.82	3,000	4.6
Mexico	13,514	1948	22,226	0.61	769	17.6
World Total	751,400	1948	2,170,200	0.35	51,235	14.7

[1] *Agricultural Statistics*, U. S. Dept. of Agri., 1949, pp. 345, 346.
[2] J. Whitaker, *Whitaker's Almanac for 1948*, London, England, 1947, pp. 193-198.
[3] *The Economic Almanac for 1948*, National Industrial Council Board, New York, N. Y., 1947, pp. 1-5 and 264.

The United States is excelled in aggregate cattle numbers only by India. But India is of very negligible importance so far as world trade is concerned. This is due to a large number of Indian cattle either being sacred or used for draft purposes and the fact that water buffaloes are included along with cattle numbers.

At the present time, it appears that certain of the South American nations, Mexico, Canada, and possibly Australia are the only countries which produce more than their domestic needs and thus have surpluses or potential surpluses of beef for export. Much of the time neither beef nor cattle on foot are allowed entry from these countries because of foot-and-mouth disease or tariffs.

[1] *The Livestock and Wool Situation*, U. S. Dept. of Agri., Bur. of Agr. Econ. Situation Rpt. May-June, p. 15.



Fig. 130. Scene in India showing water buffaloes (3 animals to left) and cattle. As these animals travel to pasture, they are usually herded by the young or old of the village. (Courtesy, Dr. Ralph W. Phillips.)

Beef Production in South America

Of the South American countries, Argentina is recognized as the outstanding beef producer. In fact, taken as a whole, Argentine cattle probably possess better breeding and show more all-round beef excellence than do the cattle of any other country in the world. The excellence of the Argentine cattle can be attributed to two factors: their superior breeding and the lush pastures of the country. Beginning in 1850 and continuing to the present time, large numbers of purebred animals were imported from England and Scotland. No price has been considered too high for bulls of the right type; and, again and again, British and American breeders have been outbid by Argentine estancieros in the auction rings of Europe. These bulls and their progeny have been crossed on the native stock of Spanish extraction. Shorthorns are the most numerous cattle of the country, with Herefords ranking second and Aberdeen-Angus third.

The finest cattle pastures of the Argentine are found along the La Plata River, in the region known as the Pampas. Much of this fertile area is seeded to alfalfa upon which cattle are pastured the year round. Instead of fattening cattle largely on grains, as we do, the cattlemen in the Argentine fatten their stock on alfalfa pastures. The corn of the Pampas region, which represents an acreage one-half as great as that devoted to alfalfa,

is largely exported. Usually the steers are two to three years of age when turned into the alfalfa for fattening, where they remain for four to eight months before being sent to market. During normal times, the surplus beef of Argentina is marketed as frozen or chilled beef to the European countries, especially to Great Britain. None of the frozen or chilled beef from the Argentine is admitted into the United States because of the hazard of foot-and-mouth disease.

Other South American countries of importance in beef production include Brazil, Uruguay, and Paraguay. Brazil is one of the largest countries in the world, whereas Uruguay is but little larger than the state of Oklahoma. Paraguay is three times the size of Uruguay. Uruguay is noted for being the most highly specialized beef-producing country in the world and, despite its small size, has available a considerable quantity of beef for export. The cattle of Uruguay are of good breeding, although they do not possess quite the excellence of those in the Argentine. The cattle in Brazil and Paraguay are inferior to those of either Uruguay or Argentina. A considerable number of Zebu cattle have been crossed on the native cattle in both Brazil and Paraguay. This crossing has produced animals that are hardy.

As in the Argentine, year-round grazing constitutes the basis of the beef cattle industry of the other South American countries. Virtually no grain is used in fattening animals, except for those being fitted for show. No attempt is made to fatten steers until they are fully mature.

In general, the foremost obstacles or unfavorable factors affecting South American beef production are the following:

1. The ever-present foot-and-mouth disease, which, though seldom fatal, results in enormous economic losses through arrested growth and emaciation and which limits the foreign sale of both beef and cattle on foot.

2. Droughts are rather frequent in many of the cattle sections, and they are likely to be of rather long duration.

3. Parasites and certain diseases other than foot-and-mouth disease are rather prevalent in the warmer sections.

4. Prices are very much dependent upon the export trade, thus making for an uncertain market.

5. Local markets are often unsatisfactory; modern packing plants are not too plentiful; and refrigeration facilities are limited. Many of the cattle slaughtered in the more isolated areas of South America, especially in Brazil and Paraguay, are still made into jerked or salted beef.



Fig. 131. Cattle round-up in Canada. On their way to summer pasture, his herd fords the Milk River in southern Alberta. Canada, which is still a frontier type of country with almost unlimited opportunities for expansion of the beef cattle industry, has approximately 9,000,000 head of cattle. (Courtesy, Canadian National Film Board.)

6. Transportation facilities are few and far between.

7. Except for the cattle of Argentina and Uruguay, much improvement in breeding is needed; but the introduction of improved blood is difficult because of the heavy infestation of diseases and parasites to which the native and Zebu cattle are more resistant.

Because of the glowing reports about the cattle industry of Argentina, many young men from the United States have, from time to time, been interested in establishing a cattle enterprise in South America. Without exception, experienced United States cattlemen who have visited in South America in person and who know whereof they speak point out the almost impossible odds of success in such a venture. In the first place, the land is in the hands of a comparatively few families who hold a monopoly on the cattle industry; and secondly, the political unrest in these countries is usually not conducive to such private foreign investments in land or cattle.

Beef Production in Canada

Canada is still a frontier type of country with almost unlimited opportunities for expansion of the beef cattle industry. In general, Canadian cattle are noted for their size, scale, and rug-

gedness. This is due to the fact that in the great expanses of frontier agriculture cattle production is on a cost-per-head rather than on a cost-per-pound basis; that is, it costs little more to produce a sizeable beast than to produce a small one. The main obstacles to increased beef production in Canada are: (1) the long severe winters in much of the cattle country centered primarily in the eastern and western provinces where up to seven months feeding is required; (2) the high duty and frequently closed borders for exports to the United States, the most natural potential market; and (3) the need for a permanent outlet for stocker and feeder cattle, as Canada has no fattening area comparable to the Corn Belt.

The cattlemen of Canada appear to be optimistic about the future of the industry. It is predicted that more and more cattle will be fattened on the small grains which are produced in great abundance. Moreover, the opening up of the St. Lawrence-Great Lakes waterway to shipping by boat will permit cheaper water transportation, perhaps resulting in establishment of packing plants at Port Arthur. This would save a rail journey of more than 2,000 miles to Montreal or Quebec.

Beef Production in Mexico

Since 1946, no imports of Mexican cattle have been permitted into the United States because of a widespread outbreak of foot-and-mouth disease in that country. The primary concern of the American cattle producer at the present time, therefore, is the establishment of such rigid controls as to prevent this dreaded disease from crossing the United States border. To this end, thousands of trained scientists and regulatory officials have been dispatched to Mexico; and the United States government has joined with the government of Mexico in spending millions of dollars in attempting to eradicate the disease. Thus, at the present time, the cattle industry of Mexico is of interest because of past accomplishments and future possibilities rather than any existing importance in the beef markets of the world.

In addition to their importance to the sizeable ranching industry of Mexico, cattle are still a main source of power in that country. The latter fact created a major obstacle in carrying out the slaughter method of control in connection with the recent foot-and-mouth disease control program. Many of the poor people of the peon class lost their only oxen. Replacement of the oxen by Missouri mules only added to the dilemma; for it was then

necessary that the Mexican either speed up his pace in order to follow the mule or that the mule slow down his gait in keeping with that of the Mexican. Reports are to the effect that the Missouri mule extended the usual consideration for which he is noted.

In addition to the foot-and-mouth disease hazard, other factors unfavorable to beef production in Mexico are: (1) the ravages of parasites, particularly the Texas tick; (2) lack of improved breeding, which is made difficult because of the susceptibility of newly imported cattle to diseases and parasites; and (3) frequent droughts, which, next to foot-and-mouth disease, constitute the greatest of all obstacles.

Despite all the difficulties now existing in Mexico, the fact remains that cattle are afforded a long grazing season and that labor is cheap and abundant. Cattle can be produced very cheaply. If the country is freed from foot-and-mouth disease and if imports into the United States are again permitted, it is reasonable to expect that Mexico will annually provide several thousand head of steers for fattening on the ranges of the Southwest or for shipment to the Corn Belt feed lots.

Beef Production in Australia

Normally, Australia slaughters from 400,000 to 500,000 cattle for export annually. Most of these cattle are grazed the year round. Slaughter steers usually consist of four-year-old animals that are grass fattened. Many of the ranches are very large in size, varying from 100,000 to over 1,000,000 acres each and carrying from 10,000 to over 50,000 head of cattle. Few holdings are fenced, the cattle being herded by "musterers" who are the counterpart of the American cowboy.

The beef cattle industry of Australia is subjected to unfavorable factors much like those of South America, except that the country is free from foot-and-mouth disease. In comparison with South America, however, the greater distance from Europe imposes a heavy burden upon shipping facilities and makes it almost impossible for Australian exporters to compete on any equitable basis.

BEEF PRODUCTION IN THE UNITED STATES

The present importance of beef cattle in the agriculture of the nation rests chiefly upon: (1) their ability to convert coarse forage, grass, and grain crops into a palatable and nutritious food for human consumption; (2) the part they play in the



Fig. 132. An Australian "musterer" (who is the counterpart of the American cowboy) watching over a fine herd of breeding cows that are watering along a creek in the black soil alluvial country. In 1948, Australia had 13,785,000 head of cattle. There is a big export of Australian chilled beef. (Courtesy, Australian News and Information Bureau.)

maintenance of fertility through returning to the soil approximately 80 per cent of the plant-food value of the crops that are marketed through them; and (3) their influence upon the use of crop rotations.

The 1940 census indicated that cattle were kept upon 79.5 per cent of all farms and ranches and that the average herd had 13.3 animals. In 1950, there were 80,277,000 cattle and calves on the farms and ranches of the United States. This represents an increase of 2,151,000 head since 1948. Because of the pastures released by declining horse and sheep populations, plenty of forage appears to be available for some expansion in cattle numbers.

The production of beef cattle differs from that of most other classes of livestock in that the operation is frequently a "two-phase" proposition: (1) the production of stockers and feeders and (2) the fattening of cattle. In general, each of these phases is distinctive to an area. The production of stockers and feeders, or the cow-and-calf proposition, is characteristic of the western

range, whereas the fattening of cattle is characteristic of the Corn Belt.

Areas of Beef Production

In addition to phases of production found in the two major cattle-producing areas—the western range and the Corn Belt—there are some rather characteristic production practices common to the other two less extensive areas: the Cotton Belt and the Appalachian and Great Lakes region. Certainly, within each

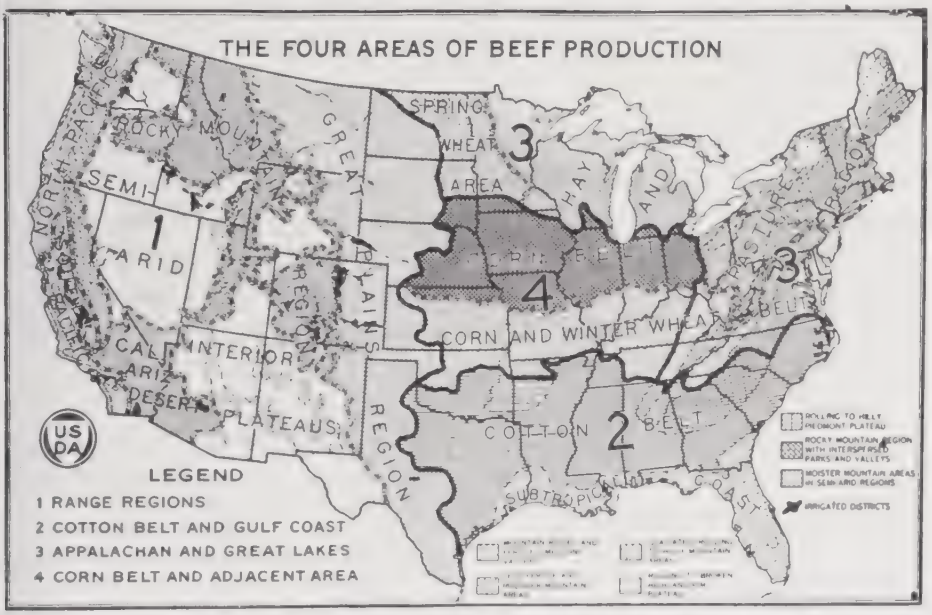


Fig. 133. The four important U. S. areas of beef production. In each area the methods followed are determined largely by the climate, feed supply, and economic conditions. (Courtesy, U.S.D.A., Bureau of Animal Industry.)

area, variations from the most common practice are noted. For example, a goodly number of cattle are fattened out in feed lots located in or near irrigated districts in the western range area, and many Corn Belt farmers have long successfully adhered to a cow-and-calf type of enterprise.

THE WESTERN RANGE:

This area lies west of an irregular north and south line cutting through the Dakotas, Nebraska, Kansas, Oklahoma, and Texas. It is characterized by great diversity of topography, soil, rainfall, and temperature. Accordingly, the amount of vegetation and the resulting carrying capacity are variable factors. Except in some small areas under irrigation, the units of operation are large in size, and much of the range remains unfenced. In gen-

eral, the western ranges supply an abundance of cheap grass but only a very limited amount of grain. Under these conditions, the cow-and-calf system is the dominant type of enterprise.

It has been estimated that about one-half of the cattle from the western ranges are sold for slaughter, whereas the remainder are purchased for further feeding or grazing. The more famous grass-fattening areas of the West—where the pastures normally are sufficiently good to produce animals suitable for slaughter without grain feeding—include the Sand Hills of Nebraska; and the Flint Hills of Kansas and Oklahoma (sometimes referred to as the blue-stem pastures of Kansas and the osage pastures of Oklahoma).

THE CORN BELT:

The Corn Belt is noted for its fertile-soil, medium-sized farms, high-priced land, and its livestock-feeding operations. Most of the land is well suited to crop production, especially to corn. It is not surprising, therefore, that it is the cattle fattening center of the United States. Beef cattle, dairy cattle, and hogs compete for the available feeds.

Many of the farmers maintain small commercial breeding herds, the offspring of which are fattened out on home-grown feeds and sold at an early age. Luxuriant pastures furnish practically all the feed for the breeding herds from May to November, and cornstalks and other roughages are utilized as winter feeds.

In addition to keeping small breeding units, many Corn Belt farmers make a regular practice of buying in feeder cattle from the western ranges. These cattle are usually purchased in the fall of the year and are obtained through public stockyards, at auctions, through dealers, or direct from the range. Some of these are roughed through the first winter by utilizing stubble or stalk fields and then fattened on pastures the next season. Other cattle are carried on a program of winter feeding.

The Corn Belt occupies a unique location, with the range country to the west and the industrial meat-deficit area to the east. Thus, the natural movement of cattle is from west to east; and, in typical "two-phase" production, the feeder cattle are produced on the western ranges and are fattened and slaughtered in the Corn Belt. The carcasses are then shipped east for consumption. About 62 per cent of the cattle of the United States are located west of the Mississippi River, whereas 70 per cent of the human population is east of this location.

The Corn Belt is also noted for its excellent purebred herds. Because of their proximity to the western ranges and the demands of the ranch owners for bulls, there has always been a good market for superior breeding stock.

THE APPALACHIAN AND GREAT LAKES REGION:

The Appalachian and Great Lakes region is a densely populated area with great cities; it is noted for its manufacturing and commerce. The topography varies all the way from small, fertile valleys to mountainous territory. The valley areas are devoted to intensive methods of cultivation, whereas much of the upland area produces pasture and hay crops for the dairy enterprise. Much of this land is rough and stony, making it unsuitable for cultivation. The agriculture is of a most intensive type, with small farm units and very limited diversification. Many of the more distant areas that cannot be used to advantage for the production of a perishable product like market milk have been used for dual-purpose or beef production.

The production of beef cattle was formerly an important and highly developed industry through the Northeast. However, the opening up of the western ranges; the rapid increase in population of the East, with the resulting industrialization; the division of the eastern farming lands into smaller units; and the adoption of more intensive systems of farming caused a decline of beef production in the eastern states. With these changes in economic conditions, beef production has to a large extent been supplanted by dairying. With the existence of these favorable conditions for milk production, beef cattle cannot compete with dairy cattle, particularly on small farms. On the other hand, where dairying is not feasible because of overproduction and consistent low prices for market milk, where the distance to market is too great, or where labor difficulties exist, beef cattle may come into increasing importance. But this industry, in the East, can never regain its former magnitude or hold the place it does in the West or Middle West.

In general, the less accessible areas of the Appalachian and Great Lakes region are devoted to dual-purpose production rather than to either straight dairy or beef enterprises. More dual-purpose herds are found in this area than in any other section of the country. Western Pennsylvania, Ohio, and upper New York enjoy a national reputation for Milking Shorthorns; whereas in the New England states, both the Milking Shorthorn and Devon breeds are very popular.

Included in this region are also the famous residual limestone lands of Kentucky (the best of which are used for horses) and the excellent pastures of Virginia, West Virginia, and North Carolina. Feeders of commercial cattle are located in Lancaster and Chester counties in Pennsylvania, where cattle are fattened primarily on corn.

THE COTTON BELT:

The Cotton Belt—which includes all or portions of each of the twelve southern states, stretching from eastern Texas to Virginia—has always been noted for its great acreage of cotton. However, with several years of low prices for this commodity prior to World War II and with ruinous soil erosion and farm abandonment caused by careless cultivation of rolling lands, there has been in recent years a decided interest in more diversification throughout the South. Mild winters and the fact that grazing throughout the year can usually be depended upon have encouraged many a southern farmer to turn to beef production.

Another factor which in the past has seriously retarded beef production throughout a part of the South has been the presence of the cattle fever tick together with a heavy infestation of numerous internal and external parasites. With the eradication of the tick and the pushing of the "quarantine line" toward the Gulf, this difficulty has been almost completely removed. Furthermore, it has been found that Brahman cattle are more resistant to cattle tick fever than other breeds, and the infusion of blood from this breed has been of great importance.

In addition to a reduction in the cotton acreage and the control of cattle tick fever, scientific findings also have assisted the livestock program of the South through providing suitable supplements for mineral deficiencies and methods of improving pastures and controlling parasites. The cattle of the area have also been improved through shipping in large numbers of purebred and high-grade cattle from the Corn Belt and the West. All of these improved conditions, together with year-round grazing of the area, would indicate that the South can and will expand its beef production on a sound basis.

Leading States in Beef Production

A ranking of the ten leading states in beef cattle production, together with total numbers for the United States, is given in Table 23. As may be noted, Texas is far in the lead, with

Nebraska and Iowa in second and third positions, respectively. The large cattle numbers in the state of Texas may be attributed to the fact that it represents a truly great range-cattle country and to the immense size of the state. The cattle population of Nebraska, Iowa and the other central states consists of native breeding herds and the sizeable cattle-fattening operations that go hand in hand with the great acreage of corn.

TABLE 23

TEN LEADING STATES IN BEEF CATTLE NUMBERS, BY RANK, 1949, WITH AVERAGES FOR 1944-1948[1]

State	Average 1944-1948 In Thousands	1949 In Thousands
Texas	7,052	6,501
Nebraska	3,198	3,082
Iowa	3,502	3,008
Kansas	2,887	2,660
South Dakota	1,872	1,888
Montana	1,674	1,683
Missouri	1,891	1,593
Colorado	1,532	1,496
Oklahoma	1,806	1,434
Illinois	1,719	1,430
Total, United States	48,093	41,770

[1] *Livestock Market News, Statistics, and Related Data, 1947*, U. S. Dept. of Agri., July, 1948, p. 1; and *Livestock Market News, Statistics, and Related Data, 1949*, U. S. Dept. of Agri., August, 1950, p. 1. Cattle kept for milk excluded.

FACTORS FAVORABLE TO BEEF CATTLE PRODUCTION

Some of the special advantages of cattle as compared to other kinds of livestock on the farm or ranch are:

1. Beef cattle efficiently utilize large quantities of coarse low-grade roughages produced on the farm or ranch, including straws and stover, coarse or low-grade hays, and coarser pastures or ranker growth.

2. Beef cattle are well adapted to the use of the millions of acres of land unsuitable for the production of bread grains or for any other type of farming. Such areas include the arid and semi-arid grazing lands of the West and Southwest (which beef cattle share with sheep) as well as the brush, forest, and cut-over lands and swamp areas found in various sections of the United States.

3. Cattle can use the total home-grown production of grains and roughages, with or without the purchase of other feeds, more efficiently than any other class of livestock.

4. Beef cattle require less labor for their care than do other farm animals. Under average commercial range conditions, one man is required for about two hundred cows.

5. Beef cattle greatly help to distribute the labor requirements throughout the year; they require but little attention except during the winter months.

6. Cattle afford a splendid means of maintaining soil fertility. In addition to returning to the soil approximately 80 per cent of the fertilizing constituents in their feeds, cattle offer a profitable way in which to utilize soil-building legumes that are usually a part of improved crop rotations.

7. Beef cattle require a comparatively small investment in buildings and equipment.

8. Cattle entail little death risk, as they are susceptible to comparatively few diseases and parasites. For example, it is usually assumed that the death losses of steers in the fattening lot will not exceed 2 per cent.

9. Beef cattle production provides an elastic outlet for grain. When plentiful, more grain can go into beef. When scarce, less grain and more grass and roughage will still produce beef.

It is recognized that certain of the favorable factors listed above apply to both beef and dairy cattle.

FACTORS UNFAVORABLE TO BEEF PRODUCTION

Some factors which, under certain conditions, may be unfavorable to beef cattle production are:

1. A beef cattle herd cannot be built up quickly. Ordinarily, a heifer should not calve until at least twenty-four months of age, and usually only one young is produced at a time. Thus cattle are neither as prolific nor as early breeders as either sheep or hogs.

2. Should the federal controls on beef (tariffs, quotas, and embargoes) ever be completely lifted, the cattlemen of the United States would suffer ruinously low prices.

3. The presence of foot-and-mouth disease across the Mexican-United States border places this dreaded disease in an uncomfortably close position.

4. During boom periods, high-quality purebred bulls are usually excessively high and difficult to obtain.

5. The operation of a cattle ranch requires a sizeable investment in cattle. Likewise, it is costly to establish a purebred herd.

6. The grazing regulations on the various federal- and state-controlled lands are often difficult to comply with.

7. Cattle fattening is often a risky venture; many a cattle feeder has literally "lost his shirt" in the enterprise.

8. Because of the high cost in conducting fundamental research with large animals, it is probably a true statment of fact that there is less real knowledge available about beef cattle than about any other class of livestock, with the possible exception of horses.

9. Under conditions in which it is desired that the maximum economy be obtained in converting concentrated feeds into meat, both the pig and the sheep are superior to beef cattle.

10. The spread in price in market cattle is usually greater than is obtained in any other class of livestock. Shelly old cows that have outlived their life of usefulness in the breeding herd will bring comparatively less than an old brood sow. In other words, a great spread usually exists between the price of Prime steers and Canner cows.

11. Unless cold-storage facilities are available, beef cannot be cured and stored on the farm as easily as pork.

THE FUTURE OF THE AMERICAN BEEF CATTLE INDUSTRY

The far-seeing cattleman is constantly projecting his thoughts into the future. This is but natural. Some of the factors of importance to the beef cattle industry of the future are:

1. **Foreign competition.**—Most of the South American countries—especially Argentina, Brazil, Uruguay, and Paraguay—and Canada, Mexico, and possibly Australia are well adapted to beef cattle production. Many of these countries produce great surpluses; for example, in Argentina and Uruguay there are three and four head of cattle per capita, respectively. In the present scientific age, it is quite likely that rather rapid advances will be made in the control of parasites and diseases affecting cattle in each of these countries. Moreover, because of cheaper labor and feed supplies, ranchers in these countries can produce beef at a lower cost than the American cattleman. Transportation distances and costs are not prohibitive in obtaining beef from any of these countries, except possibly from Australia; and, even in this case, the situation is not insurmountable. It would appear, therefore, that only protective walls—tariffs, quotas, and em-

bargo legislation enacted by the United States government—can stand in the way of increased beef competition from foreign sources.

The same factors enumerated as affecting beef imports operate relative to possible beef exports from the United States. Because of our higher production costs—even if other factors were favorable for expansion—it is not likely that we could compete on a long-time basis with these foreign countries in exporting beef to the deficit areas of the world.

Thus exports of beef offer little possibility, but possible imports are likely to harass the cattle producers of this nation for some years to come.

2. **Increased human population.**—The population of the United States continues to expand and now approaches 150,000,000. It is reasonable to surmise that—as has happened in the older and more densely populated areas of the world—gradually less meat per capita will become available; dairy and poultry production will increase; and more and more grains will be consumed directly as human foods. This does not mean that the people of the United States are on the verge of going on an Asiatic grain diet, but history often has an uncanny way of repeating itself—even though such changes come about ever so slowly. Certainly, these conditions would indicate the desirability of eliminating the less efficient animals.

3. **Land use.**—The two major beef-producing areas of the United States are the Corn Belt and the western range. With the drastic reduction in the range sheep industry, beginning in 1941, a considerable acreage of grazing land has been released for cattle production or for other purposes. Certain range areas of the West are not now stocked to capacity. It must be remembered, however, that the range sheep industry is "making a come back". Also, maximum stocking cannot be based on the good pasture years which usually are determined by moisture conditions. The unfortunate experiences resulting from overstocking and inadequate forage supplies during the drought years is not pleasantly recalled by many cattlemen.

Each year, more areas are being brought under irrigation in the far West. Without doubt, these will provide for some expansion of the beef industry, particularly from the standpoint of supplying a greater abundance of cheap feed, some of which will be utilized in cattle-fattening operations and some for wintering

the breeding herd. It is quite likely also that much of the more marginal land of the West, which was plowed and placed in grain production because of the remunerative grain prices received since the outbreak of World War II, will be turned back to pastures.

No great expansion in the beef-cattle industry of the Corn Belt is anticipated. Some additional grazing facilities will probably become available as a result of increased grass-legume seedings for soil conservation purposes and continued reduction in horse numbers, but there will be competition from dairy cattle. Swine and sheep will also continue to compete for the available feeds in the Corn Belt.

One of the brightest hopes for expanding the United States beef cattle industry is in the South. With year-round pastures, the southern states are in a very strong position. Moreover, recent scientific developments offer new possibilities of controlling the parasites so common to the warmer climates. In the final analysis, however, the future development of the beef industry of the South is dependent upon (1) the comparative profits to be derived from cotton, peanut, and tobacco farming in relation to livestock farming and (2) the steps which may be taken toward controlling the ravages of soil erosion, either through private initiative or government subsidy programs.

The industrial East is and will continue to support a predominantly intensive type of agriculture, with dairy and poultry dominating the livestock situation. There is room for increased beef cattle numbers, however, in some of the more isolated areas of the Northeast and East. Dual-purpose production also has a place in such areas.

On the basis of land use, therefore—and with all available factors considered—it does not appear that any marked increase in United States beef cattle numbers can be expected in the future.

4. **Quality of cattle.**—In 1930, the last year that this particular census item was taken, only 3 per cent of the total cattle population of the United States consisted of registered purebreds. Certainly, there is no "halo" around purebreds, and animals are not outstanding merely by virtue of being purebreds. But this is one criterion of the status of cattle improvement. Perhaps the most convincing evidence of the great need for further improvement in beef cattle numbers may be gained through

casually inspecting the daily livestock receipts on any central market.

Despite the acknowledged needs for continued improvement, it must be admitted to the everlasting credit of the American cattlemen that we have travelled a long way from the days of the Texas Longhorn to the prime bullock of today. Improved breeding together with improved feeding and management practices—including the marketing of cattle at earlier ages—have made it possible to retain about the same per capita beef consumption throughout the years, even though the human population of this country has expanded much more rapidly than the cattle population since 1890. But this is not the end of beef cattle improvement! With our present knowledge of genetics, nutrition, pathology, and production and management, new achievements in beef cattle improvement are on the horizon. The Regional Beef Cattle Breeding Laboratory programs offer a modern and scientific approach to further advancement.

5. **Prices.**—Both purebred and commercial cattle prices have climbed. Basically speaking, the value of both purebred and commercial cattle is determined by the price of meat over the block. Over a long period of time, it would be better for the cattle industry if the violent price fluctuations that have characterized the past could be reduced by dampening the enthusiasm of boom periods and stimulating interest during periods of depression.

CHAPTER X

TYPES AND BREEDS OF BEEF AND DUAL-PURPOSE CATTLE

Early in the progress of cattle improvement, especially during the development of fenced holdings in England, man began to select out certain animals for specific purposes and to plan matings with such uses in mind. Fortunately, because of the diversity of genes carried by the parent stock, it was possible, through selection, to mold certain types, each of which proved superior to the common cattle or even to other types for specific purposes. Thus, there evolved beef-type, dairy-type, dual-purpose-type, and draft-type cattle.

THE FOUR TYPES OF CATTLE

Type may be defined as an ideal or standard of perfection combining all the characters that contribute to the animal's usefulness for a specific purpose. It should be noted that this definition of types does not embrace breed fancy points. These have certain value as breed trademarks and for promotional purposes, but in no sense can it be said that they contribute to an animal's utility value. There are four distinct types of cattle: beef-type, dairy-type, dual-purpose-type, and draft-type.

Beef-type animals are characterized by great width and depth of body and short legs. Their primary purpose is to convert feed efficiently into the maximum of high quality meat for human consumption.

Dairy-type animals are characterized by a lean, angular form and a well-developed mammary system. Their type is especially adapted to the efficient conversion of feed into the maximum of high quality milk.

Dual-purpose-type animals are intermediate between the beef type and dairy type in conformation and also in the production of both meat and milk.

Although many breeders have the dual-purpose-type clearly in mind and although many fine specimens of the respective breeds have been produced, there is less uniformity in dual-

purpose cattle. This is as one would expect when two important qualifications, beef and milk, are being combined.

Draft-type animals, when true to form, are characterized by great size and ruggedness with considerable length of leg. Al-

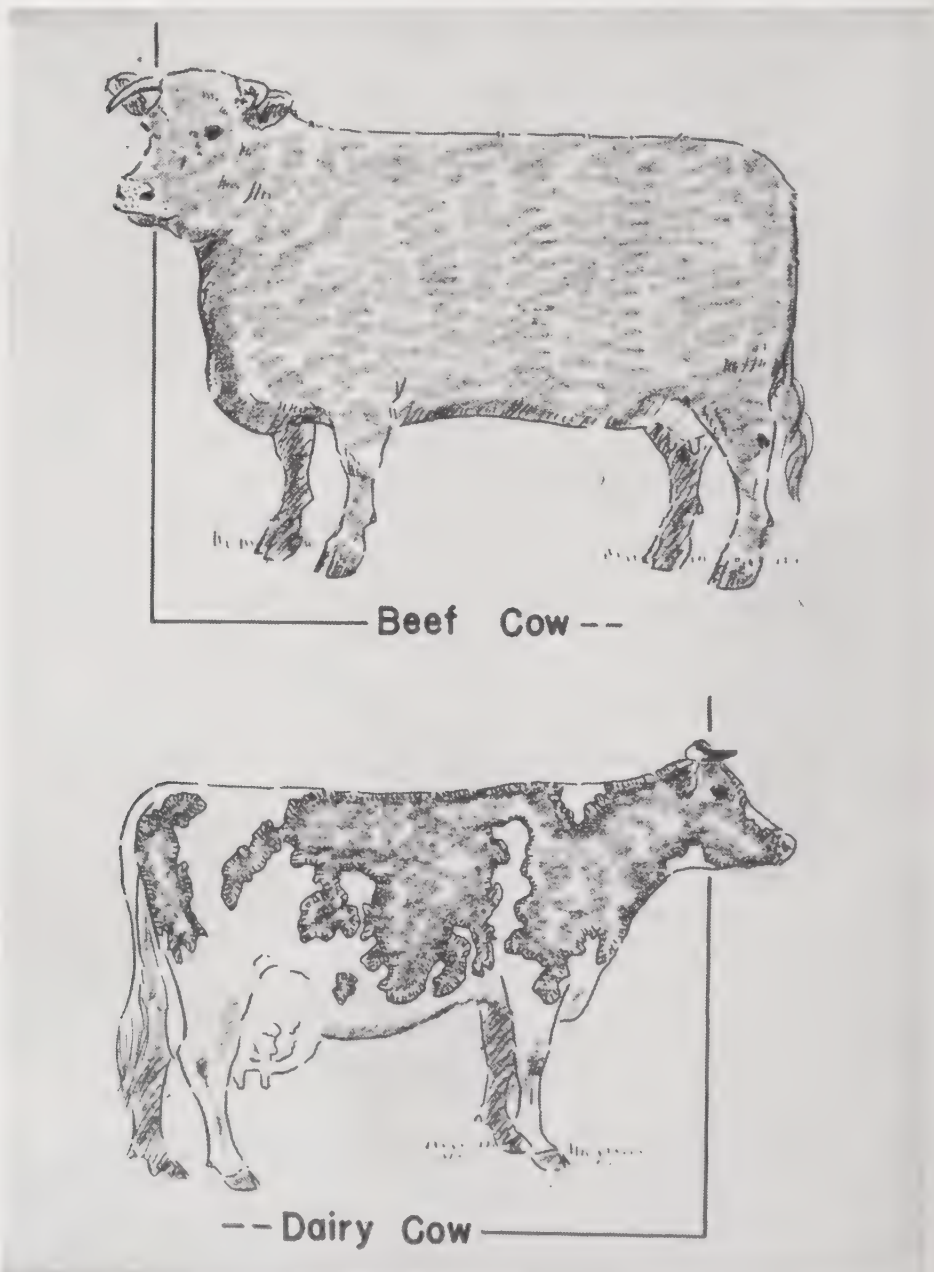


Fig. 134. Beef-type cow (above), characterized by great width and depth of body and short legs. Dairy-type cow (below), characterized by a lean, angular form and a well-developed mammary system. (Drawing by R. F. Johnson.)

hough oxen are seldom seen in the United States, except in the New England states, it must be remembered that these patient, teady, plodding beasts are still the chief source of power in nany parts of the world.

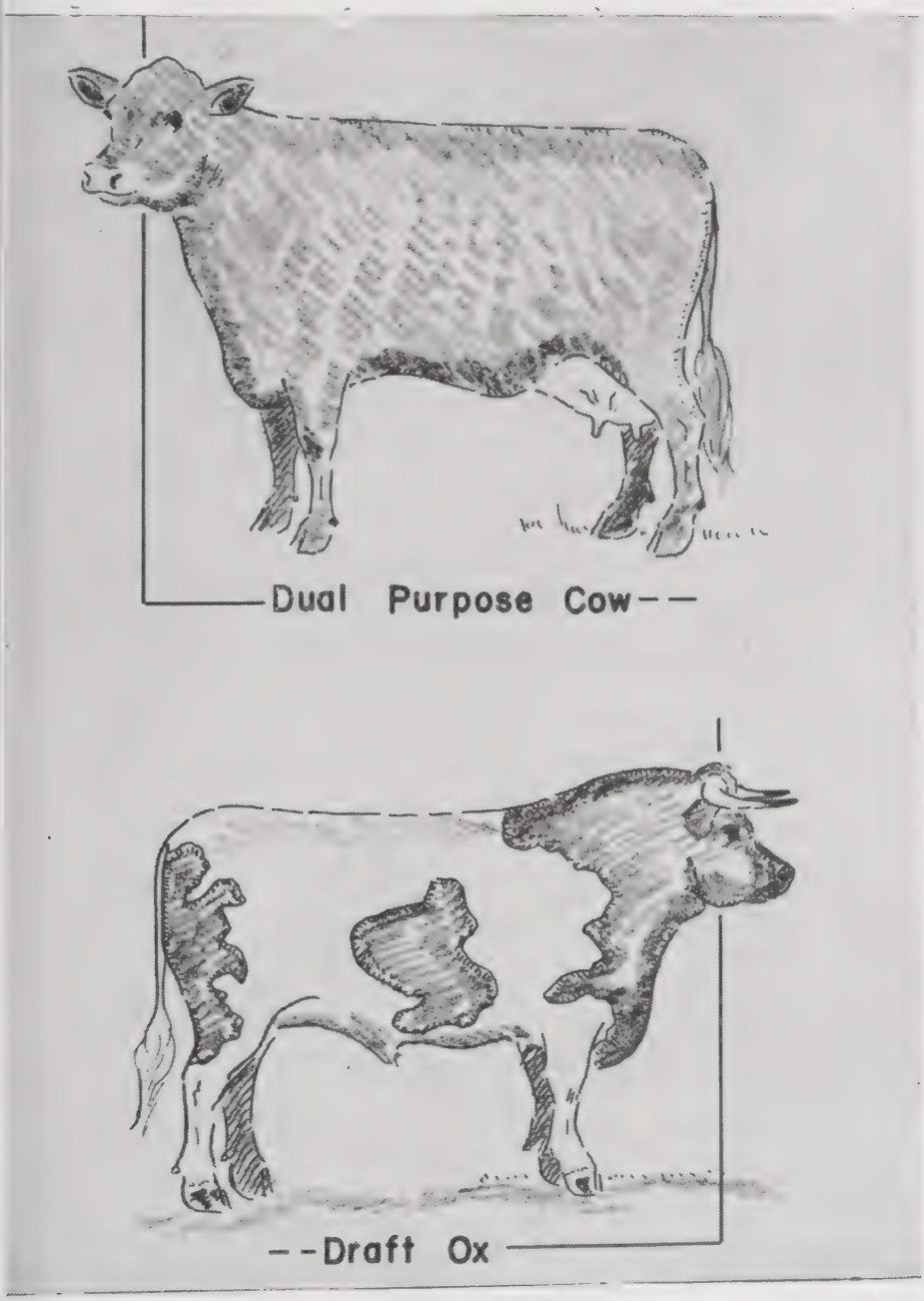


Fig. 135. Dual-purpose-type cow (above), intermediate between the beef-type and dairy-type in conformation. Draft-type ox (below), characterized by great size and ruggedness with considerable length of leg. (Drawing by R. F. Johnson.)

Several distinct breeds of cattle of each of the types have been developed in different parts of the world. Although each of these breeds possesses one or more characteristics peculiar to the group (breed characteristics), in general, the type of cow that will produce a large flow of milk is the same the world over, despite acknowledged differences in size, color, shape of head and horns, or in any other distinctive breed characteristic. Likewise, there is a general similarity between all the beef-type breeds. Moreover, because of the great diversity of genes within any given breed, there is more difference within beef breeds than between beef breeds insofar as beef type is concerned.

THE COMMON BREEDS OF BEEF AND DUAL-PURPOSE CATTLE IN THE UNITED STATES

A breed may be defined as a group of animals having a common origin and possessing certain well-fixed and distinctive characteristics not common to other members of the same species; these characteristics are uniformly transmitted. A breed may come about as a result of planned matings; or, as has been more frequently the case, it may be purely a "happenstance." Once a breed has evolved, a breed association is usually organized.

The common breeds of beef and dual-purpose cattle in the United States, classed according to type or purpose for which they are primarily produced, are:

Beef breeds	*Dual-purpose breeds*
Aberdeen-Angus	Devon
Brahman (Zebu)	Milking Shorthorn
Galloway	Red Poll
Hereford	
Polled Hereford	
Santa Gertrudis	
Shorthorn	
Polled Shorthorn	

RELATIVE POPULARITY OF BREEDS OF BEEF AND DUAL-PURPOSE CATTLE

Table 24 shows the 1949 and total registrations to date of the common breeds of beef and dual-purpose cattle. In these changing times, the recent annual figures are probably more meaningful than the all-time registrations, although it is recognized that one year's data, only, fails to show trends.

TABLE 24

949 AND TOTAL REGISTRATIONS OF BEEF AND DUAL-PURPOSE CATTLE IN UNITED STATES BREED ASSOCIATIONS[1]

Breed	1949 registrations	Total registrations
Iereford	307,015	6,210,878
berdeen-Angus	87,772	1,255,600
horthorn	45,915	3,266,054
olled Hereford	37,100	414,012
Iilking Shorthorn	35,689	185,000
rahman	17,220	128,090
olled Shorthorn	10,686	234,621
ed Poll	4,402	185,909
evon	416	33,000
alloway	373	52,201
anta Gertrudis		

[1] *New England Homestead*, Springfield, Mass., Sept. 23, 1950, Vol. 123, . 40.

THE BEEF BREEDS OF CATTLE

The ultimate objective in beef production is the sale of beef ver the block. But this is not enough. In this day and age, it is lso imperative that feeds be *efficiently* converted into the maxi- num of high quality meat. How well the different breeds measure p to these requisites will determine their popularity in the uture.

The Aberdeen-Angus

The Aberdeen-Angus is the most recent of the three major eef breeds to be brought to America. At the time Professor rown first introduced a breeding herd of Aberdeen-Angus to merica, Shorthorn cattle had been in this country ninety-five ears and Herefords fifty-nine years.

ORIGIN AND NATIVE HOME:

The native home of the Aberdeen-Angus breed is in north- astern Scotland, in the counties of Aberdeen, Kincardine, and orfar. In its native home, the breed was often referred to as "Buchan Humlies" or "Angus Doddies," the words "homye" and "doddle" being Scotch terms for polled or hornless. The area in which they originated may be described as rolling to rough and ot particularly fertile; and the climate is cold and damp much f the year. The origin is rather speculative. Some writers claim hat the breed is a sport from an earlier black, horned breed of cotland; whereas others are of the opinion that they sprang rom the polled cattle of Britain.

EARLY AMERICAN IMPORTATIONS:

An Aberdeen-Angus cow named "Duchess" was brought to the United States from Portethan, Scotland, in 1850. Then in 1873, George Grant of Victoria, Kansas, imported three bulls



Fig. 136. George Grant Memorial, Victoria, Kansas. Mr. Grant—a native of Banffshire, Scotland, and a retired London silk merchant—imported the first Aberdeen-Angus bulls into the United States from Scotland in 1873. (Courtesy, American Aberdeen-Angus Breeders' Association.)

to use on his native range cattle. However, the first breeding herd—including animals of both sexes—to be imported into the New World was brought to Canada in 1876 by Professor Brown of Ontario Agricultural College. It was not long, however, before the progeny of these early Aberdeen-Angus importations attracted attention, and other shipments from across the water followed.

BERDEEN-ANGUS CHARACTERISTICS:

Aberdeen-Angus cattle are distinguished from other breeds their black color, comparatively smooth coats of hair, and lled character. A moderate amount of white on the underline, ck of the navel, is permitted.

As a rule, Aberdeen-Angus are not quite so heavy as Short-rns or Herefords. Because of their compactness and closeness the ground, however, they are likely to be underestimated in eight.



Fig. 137. Master Prince of Sunbeam, Grand Champion Aberdeen-Angus ll, Chicago International, 1947. Owned by Reverie Knoll Farm, Danville, ntucky. Aberdeen-Angus cattle are distinguished from other breeds by eir black color, comparatively smooth coats of hair, and polled character. ourtesy, American Aberdeen-Angus Breeders' Association.)

The body of the Aberdeen-Angus may be described as some-nat cylindrical, compact, broad, deep, smooth, and heavily uscled throughout. No other breed can boast of such an en-able reputation in the fat steer classes of the show ring and in e carcass contests of the country. Aberdeen-Angus mature at early age, are heavily muscled in the regions of the high-iced cuts, and yield a quality carcass with a high dressing rcentage.

While still outnumbered in this country by both Shorthorns d Herefords, the breed is becoming more widely distributed; is especially popular in the central, southern, and western

states. The cattle are good rustlers, and seem to be able to endure both warm and cold climates. Because of their prepotency in stamping the solid color and polled characteristics, Aberdeen-Angus bulls are great favorites for cross-breeding work.

The Brahman (Zebu)

Unfortunately, the average citizen in the northern part of the United States is likely to associate the Brahman breed of cattle with either the sacred cattle of India or the wild bulls or steers of the western rodeo.[1] Under such conditions, it is not surprising to find that many people—cattlemen included—may completely overlook the peculiar adaptation of the breed to areas characterized by hot climates, heavy insect infestations, and sparse vegetation. Because of these characteristics, Brahman blood is now being added to many herds of the deep South and Southwest, and new strains of beef cattle are in the making.

ORIGIN AND NATIVE HOME:

In the United States, the names Brahman, Brahma, or Zebu are applied interchangeably to any of the more than thirty breeds of cattle native to India. Although representatives of several of these breeds have been imported to this country, our chief interest has been in the Guzerat and Nellore breeds. Without doubt, the Brahman cattle of India were domesticated and developed as provincial breeds or types long before the British breeds.

EARLY AMERICAN IMPORTATIONS:

It is very difficult to import Brahman cattle to the United States because of the reluctance of the Hindus to part with these animals that they consider sacred and the prevalence of certain cattle diseases in India, especially rinderpest and surra.

The first importation of Brahman cattle to the United States was to South Carolina in 1850, and the second was to Louisiana ten years later. In 1904, a bull and a cow that Carl Hagenbeck, of Germany, exhibited at the Louisiana-Purchase Exposition at St. Louis were sold to a Texas breeder. In 1906, A. P. Borden of Mackaye, Texas, imported thirty bulls and three cows directly from India. Other importations followed.

BRAHMAN CHARACTERISTICS:

Brahman cattle are characterized by a prominent hump over the shoulders; an abundance of loose, pendulous skin under the throat and along the dewlap; a somewhat narrow body; an upstanding appearance due to somewhat longer legs; a "tucked-up"

[1] It is reported that certain river tribes along the Nile in Egypt use Braham cattle as a medium of exchange to buy wives and settle feuds

hiddle; drooping ears; and a voice that resembles a grunt rather han a low.

Brahman cattle and their crosses appear to be particularly ell adapted to the Gulf Coast region of Texas and to southastern United States. They stand heat exceptionally well; and pparently they are little annoyed by ticks, flies, and mosquitoes. 'hey are resistant to Texas fever. They are also great rustlers 'here the vegetation is scarce, and they can travel long distances o water.



Fig. 138. Dutch Hilar, Grand Champion Brahman Bull, Corsicana Livestock and Agricultural Show, 1948. Bred and owned by Burke Bros., Corsiana, Texas. Brahman cattle are characterized by a prominent hump over he shoulders; an abundance of loose, pendulous skin under the throat and long the dewlap; drooping ears; and a voice that resembles a grunt rather han a low. (Courtesy, American Brahman Breeders Association.)

In the southern part of this country, Brahman cattle have een used in producing five promising new crossbred strains: anta Gertrudis (Brahman X Shorthorn); Beefmasters (Brahan X Shorthorn X Hereford); Brangus (Brahman X Aberdeenngus); Braford (Brahman X Hereford); and Charbray (Brahan X Chorollais, a French breed). These new strains of cattle ppear to be promising for those areas in which they are being eveloped, but additional research work should be conducted in rder to determine their true merits for these areas and elsehere in comparison with the existing beef breeds of English

extraction. It is entirely possible that the crossbred strains may possess an adaptation especially suited to those areas having hot summers, heavy insect infestation, and frequently sparse vegetation. They may even be adapted to the northern part of the United States.

The Galloway

For some obscure reason, the Galloway breed of cattle has steadily declined in importance in the United States. Some attribute this to the modesty of its friends in extoling the hardiness and thriftiness of the breed, whereas others feel that the slower development of the Galloway has prevented the breed from gaining wider popularity.

ORIGIN AND NATIVE HOME:

The Galloway breed originated in the province of Galloway, in southwestern Scotland. This country is rough and mountainous, and the climate is moist and often chilly. The pastures of the area have been described as luxuriant, even in the higher elevations.

Whether or not the cattle from which the Galloways descended were polled has been a debatable question. It seems fairly definite, however, that the breed descended from wild cattle native to the territory.

EARLY AMERICAN IMPORTATIONS:

The earliest recorded importation of Galloway cattle to America was made in 1853 by Graham Brothers, of Vaughan, Ontario, Canada. A few years later the breed was introduced into the United States. Because of their hardiness and ability to rustle in the colder regions, these cattle spread generally throughout the north central states.

GALLOWAY CHARACTERISTICS:

Black is the characteristic Galloway color; however, a brownish or reddish tint frequently occurs in the black. The hair is long and curly. White markings on the feet or legs, or above the underline, make animals ineligible for registry. The breed is polled.

The individuals are smaller than other beef breeds. The Galloway has short legs and by way of comparison with the Aberdeen-Angus, is more flat of rib and has a longer body. The meat of the Galloway is of high quality. The cattle are good rustlers and extremely hardy.



Fig. 139. Grange Commander, Galloway Bull, purchased by George Daniels, San Francisco, California for 580 guineas (about $2,500) and imported in 1948. This is reported to be the highest price ever paid for a Galloway in the history of the breed. Galloway cattle are characterized by their long, curly, black hair; hardiness; and polled character. (Courtesy, American Galloway Breeders Association.)

The Hereford

The Hereford is the dominant beef breed of the United States, both from the standpoint of purebred and commercial production. Herefords are easily recognized by the ever-present white face, the distinctive trademark of the breed.

ORIGIN AND NATIVE HOME:

The Hereford breed originated in England in the County of Hereford. This area has a rolling topography and climatic conditions that are favorable to superior grazing—factors which account for the rustling habits of the present-day Hereford. The early development of the breed is clouded in obscurity. However, "white-faced" cattle had long been in England.

It is interesting to note that one of the great paintings of the world, "The Young Bull," by Paul Potter (1625-1654), has among a group of cattle a white-faced, red-bodied cow—an individual resembling many plain-looking Herefords of the past.

EARLY AMERICAN IMPORTATIONS:

The earliest importation of Hereford cattle into the United States, of which there is authentic record, was made by Henry

Clay, of Kentucky, in 1817. He imported a bull and two females. Mr. Clay said, "My opinion is that the Herefords make better work cattle, are hardier, and will, upon being fattened, take themselves to market better than their rivals." In 1825, Admiral Coffin, of the British Royal Navy, presented a bull and a cow to the Massachusetts Society for Promoting Agriculture. These were soon followed by numerous other importations. The breed gained rapidly in favor and soon was widely scattered throughout the states.



Fig. 140. "The Young Bull," from one of the great paintings of the world, by Paul Potter. Painted in 1647. Note the white-faced, red-bodied cow—an individual resembling many plain-looking Herefords of the past. (Courtesy, The Netherlands Information Bureau.)

HEREFORD CHARACTERISTICS:

The Hereford color is distinctive. The body color varies from a medium to a rich red, and the face color is white. The white color is also found on the underline, flank, crest, switch, breast, and below the knees and hock. White coloring back of the crops, high on the flank, or too high on the legs is objectionable. Likewise, dark or "smutty" noses are frowned upon by breeders. Herefords are often referred to as the "white-face" cattle. The weight of the Hereford is only slightly less than that of the Shorthorn.

The Hereford is distinctly a beef breed. Individuals of the reed are rather rectangular in form, deep bodied, thick fleshed, nd they possess excellent constitution and vigor. The breed is articularly noted for its foraging ability, which characteristic rgely accounts for its popularity on the ranges of the West and outhwest where it outnumbers all other beef breeds combined.



Fig. 141. WHR Regality 1st, great Hereford sire, bred by Wyoming ereford Ranch, Cheyenne, Wyoming. Sold to Aldarra Farms, Seattle, ashington, for $20,000. The Hereford color is distinctive—a red body with white face. (Courtesy, Wyoming Hereford Ranch.)

he thick coat of hair, robust constitution, and easy-keeping uality of the breed make it unusually well suited to range con- tions. Although the cows are sometimes criticized for low milk roduction, in most cases they give ample milk to produce a good lf.

he Polled Hereford

The Polled Hereford breed of cattle is rapidly gaining in avor and numbers. Certainly the polled characteristic is an asset, nd—provided that enough really good Polled Hereford cattle an be produced—a bright future for the breed seems to be ssured.

ORIGIN AND NATIVE HOME:

In 1902, Warren Gammon, of Iowa, circularized the membership of the American Hereford Breeders' Association in the interest of locating Polled Herefords. He succeeded in purchasing and bringing together a foundation herd of eleven animals. From this beginning, the present Polled Hereford breed has been developed.

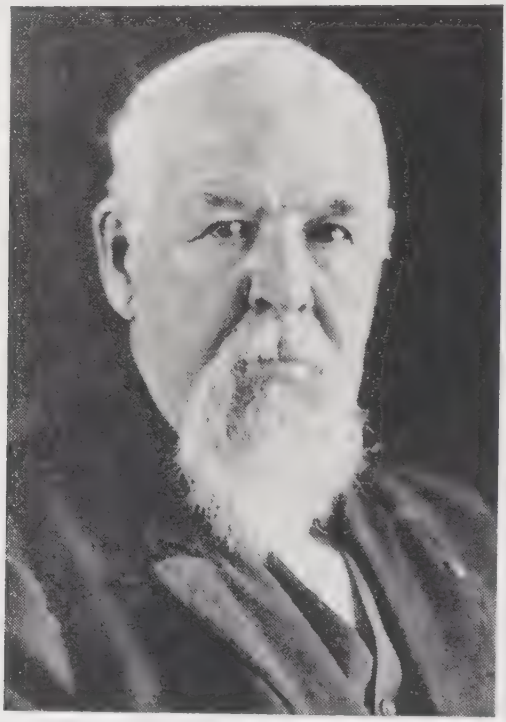


Fig. 142. Warren Gammon (1846-1923), who, in 1902, assembled the eleven Hereford mutations from which the Polled Hereford breed developed. (Courtesy, B. O. Gammon.)

POLLED HEREFORD CHARACTERISTICS:

As might be expected, Polled Herefords are similar to Herefords with the exception that they are without horns. The breed is increasing in popularity, particularly in those states where feeder cattle are produced and in regions where screw-worm infestation is troublesome.

Polled Hereford cattle that are recorded in both the American Hereford Breeders' Association and the American Polled Hereford Breeders' Association are called "Double Standard," whereas those that can be recorded only in the latter association are called "Single Standard."



Fig. 143. Numode 29th, Champion Polled Hereford Bull at the 1948 National Polled Hereford Show, Denver, Colorado. Bred and shown by John E. Rice, Sheridan, Wyoming. The Polled Hereford breed is increasing in popularity. (Courtesy, American Polled Hereford Breeders' Association.)

The Santa Gertrudis

The Santa Gertrudis breed of cattle is strictly an American creation developed by the King Ranch, of Kingsville, Texas—the largest ranch in the United States. At the present time, this breed is the most widely known of the new strains of cattle developed from the infusion of Brahman breeding.

ORIGIN AND NATIVE HOME:

In about 1910, the King Ranch was presented with a Brahman-Shorthorn bull which was subsequently turned to pasture with a purebred Shorthorn herd. Although none of these initial crossbreds were used as foundation animals for the Santa Gertrudis breed of cattle, their performance between the years 1910 to 1918 demonstrated conclusively to the management of King Ranch the value of infusing Brahman blood under the environmental and range conditions of the area.

The Santa Gertrudis breed of cattle is the result of a Shorthorn-Brahman cross—representing five-eighths Shorthorn and three-eighths Brahman. The initial cross consisted of mating 52

three-year-old seven-eighths Brahman bulls to 2,500 Shorthorn cows. The very best red heifers and bulls from this mating were retained and interbred. Finally, after two or three years of the initial cross, a very superior first-cross bull was singled out. This bull was known as Monkey, and he marks the real beginning of the breed of Santa Gertrudis cattle.



Fig. 144. Coton, a Santa Gertrudis bull. Coton is by Tipto, by Santa Gertrudis, by Monkey. Monkey was the very superior first-cross bull that is considered to be the foundation sire of the breed. Carrying five-eighths Shorthorn and three-eighths Brahman blood, Santa Gertrudis cattle are red or cherry-red in color. (Courtesy, King Ranch.)

SANTA GERTRUDIS CHARACTERISTICS:

Santa Gertrudis cattle are red or cherry-red in color. The hump over the shoulders has been eliminated, and representative animals are of very acceptable beef type. They are deep, thick and wide, and fairly low-set. They are active but not nervous. It is claimed that they are breeding remarkably true, both as to color and type.

The Shorthorn

Shorthorn cattle have a long and illustrious history, being one of the oldest of the beef breeds and the first breed of cattle to have a breed registry association.

ORIGIN AND NATIVE HOME:

Shorthorn cattle originated in northeastern England in the counties of Cumberland, Durham, Northumberland, and York.

ere, in the fertile Valley of the Tees, the Shorthorn received its rly development and improvement and then spread out over reat Britain and the civilized world. The term "Shorthorn" is erived from the fact that the early improvers of the breed ıortened, through selection and breeding, the horns of the orig- ıal "Longhorned" cattle that were native to the district. It is ot known what breeds or types of cattle were used in the early



Fig. 145. Killearn Colonel Max, Grand Champion Shorthorn Bull, Pa- ific International, Portland, 1947. Owned jointly by Wheatdale Shorthorn 'arms, (H. F. Beckley and K. J. Killingsworth, proprietors), Benge, Wash- ıgton; and Art Warsinski, Spokane, Washington. Shorthorns are the ırgest of the beef breeds. (Photo by Henry Fisher, Jr., Belmont, Wash- ıgton.)

evelopment of the Shorthorns, although it is probably safe to ssume that the early invaders of England—the Romans, Nor- nans, and others—brought over cattle which were crossed with ıative stock.

EARLY AMERICAN IMPORTATIONS:

Shorthorns were the first of the beef breeds to be brought o America. They were first introduced in 1783 by Miller and Gough, of Virginia. These men made a second importation in 792. Available information indicates that a Mr. Heaton brought Shorthorns into New York State in 1791. Other importations ollowed, and soon they were established in every part of the ountry.

SHORTHORN CHARACTERISTICS:

The breed has a wide range in color. Roans (blended red and white hairs) are perhaps most numerous, although Shorthorns may be red, white, or any combination of red and white. The skin on the nose should be "flesh color"; a "smutty nose" or dark nose is very objectionable.

In size, Shorthorns are the largest of the beef breeds. The rectangular shape is more or less characteristic of the breed. Of all the beef breeds, the Shorthorn excels in milk production, a factor which has been instrumental in making the breed a favorite on the small farm. Shorthorns are also noted for good temperament.

Two strains of Shorthorn blood are found in this country. The Bates strain, of England, led to the development of the "Milking Shorthorn." The "Scotch" strain developed in Scotland —largely through the efforts of the beloved Amos Cruickshank, "the Herdsman of Aberdeenshire"—and it is to this strain that the beef-type Shorthorns have clung.

The Polled Shorthorn

The best Polled Shorthorn cattle compare favorably with the best of their horned cousins. Certainly, the commercial producer prefers to dehorn cattle through genetic rather than mechanical means, but he will not sacrifice type and other productivity factors in order to obtain the polled characteristic. The main problem, therefore, is to produce more good Polled Shorthorn cattle.

ORIGIN AND NATIVE HOME:

Until 1919, Polled Shorthorns were known as Polled Durhams. This name was given because most of these early polled individuals came from the Shorthorn-"Muley" cross. Strains of Shorthorns developed from this cross are called "Single-Standard" animals because they are eligible for registry in the American Polled Shorthorn herd book, but not eligible for registry in the American Shorthorn herd book. Later it was discovered that naturally polled animals could be found among registered Shorthorn herds. By 1919, approximately 95 per cent of the polled strains were "double standards"; that is, they were the polled offspring of parents both of which were registered in the American Shorthorn herd book.

POLLED SHORTHORN CHARACTERISTICS:

The Polled Shorthorn breed is very similar in type to Shorthorns, except that they are hornless. In general, however, there

re more spotted animals in the Polled Shorthorn breed, and here is less uniformity in type. Yet great strides are being made improving the breed, and the best specimens compare favorably to the best horned Shorthorns.



Fig. 146. Hilldale Augusta May, Grand Champion Polled Shorthorn female of the 1948 Chicago International. This outstanding heifer was bred and exhibited by Wm. Bennett & Sons, Winona, Washington. (Courtesy, Wm. Bennett, Jr.)

THE DUAL-PURPOSE BREEDS OF CATTLE

Dual-purpose cattle represent an attempt to obtain as much beef conformation as possible and at the same time considerable milk-producing capacity. In their truest form, dual-purpose cattle cannot be classed as either strictly beef or dairy breeds. Rather, their type is intermediate, combining in one animal, insofar as possible, valuable qualities of both meat and dairy types. Because of the stress on beef or dairy qualities and the resulting ideals among breeders and judges, the dual-purpose breeds have not experienced the uniformity of type that exists either in the strictly dairy or beef breeds.

For the most part, the dual-purpose breeds have been in the hands of the farmer who lives upon his land and who makes his living from the soil. This type of farmer often prefers a type of cow that will produce a fairly liberal supply of milk, that will

fatten easily to meet the demands of the butcher, and that will also produce calves which will feed into satisfactory steers. Cows of this type are often referred to as the "farmer's cow."

One of the chief values of dual-purpose cattle lies in their flexibility of management. When dairy products are high and labor is available, the herd can be managed for market milk production. On the other hand, when dairy products are low in price or labor is not available, calves may be left running with their dams.

Three breeds of dual-purpose cattle will be discussed: Devons, Milking Shorthorns, and Red Poll.

The Devon

Devon cattle are one of the oldest breeds in existence. In the early days, these strong, rugged cattle turned the first sod of many an equally rugged New England hillside, and down through the years the "ruby reds" have played an important part in New England's agricultural progress. Even today, the greatest number of Devons in the United States is found in the New England states.

ORIGIN AND NATIVE HOME:

The Devon originated in England in the County of Devon, which lies between the Bristol and English Channels. The climate of this section is damp and chilly much of the time; the topography is rolling to rough; and the soil is only fair in fertility. Two types of Devons were developed in England. They were known, according to location, as North Devons and South Devons. The North Devons were developed as dual-purpose cattle (for both beef and milk); whereas the South Devons were developed primarily for milk production. As practically all the importations into the United States have been of the northern type and all the developmental work has been with that type, only the North Devons are discussed here.

The origin of the Devon is prehistoric; most writers claim that they descended from the aboriginal cattle in Britain.

EARLY AMERICAN IMPORTATIONS:

The Devon in America goes back to Pilgrim days. Edward Winslow, one of the Pilgrim fathers and agent of the Plymouth Colony, brought over a consignment of a bull and three heifers in 1623. Beginning about 1800, many Devons were imported to New York, Massachusetts, and other Atlantic Coast states.



Fig. 147. A fine herd of Devons on pasture at Batchelder Farm, Milford, ew Hampshire. The "ruby reds" are one of the oldest breeds in existence. addition to their rich red color, the Devon is characterized by creamy hite horns with black tips. On cows, the horns curve upward. (Courtesy, ew England Homestead.)

EVON CHARACTERISTICS:

Devons are red in color—varying from a deep, rich red to a ale chestnut—with the bright, rich "ruby red" being the most opular. The skin is yellow, and the head supports medium-sized orns that are creamy white with black tips. On the cows, the orns curve upward, but in the males the horns are shorter and ome out fairly straight from the head. The breed is of medium ze.

Devons are straight in their lines, strong in the back, level the rump, compact in form, low set, and their bodies are well overed with flesh. They show considerable refinement, having eat, clean bone which is free from coarseness. The cows are onsidered good milkers.

he Milking Shorthorn

As the name indicates, the Milking Shorthorn is a strain of horthorns bred especially for milk production. Although both he beef and milking strains are descended from the same native ome and trace to some of the same early sires and dams, years f breeding and selection have caused them to differ rather mark-dly in type and characteristics. In the United States, the milk-ng strain is known as the Milking Shorthorn; whereas in Canada, t is termed Dual-Purpose Shorthorn and in England and Aus-ralia, Dairy Shorthorn.

ORIGIN AND NATIVE HOME:

Milking Shorthorns trace back to a strain developed a century ago by Thomas Bates, of Kirklevington, Yorkshire, England. Bates bred for a reasonably good carcass animal with steady and profitable milk production. In England, the milking herds increased because of the rapid industrial development of the Victorian era and the consequent demand for more milk. Gradually the breed spread to other countries.



Fig. 148. Last Chance Royal Rose, Jr., Champion Milking Shorthorn heifer, Eastern States Exposition, 1948. Owned by Katherine P. Mills, Lake Placid, New York. The Milking Shorthorn is a strain of Shorthorns bred especially for milk production. (Courtesy, Prof. H. L. Garrigus, Storrs, Connecticut.)

MILKING SHORTHORN CHARACTERISTICS:

As might be expected, there has been a tendency for Milking Shorthorn breeders to disagree somewhat in type—some placing greater emphasis on beef qualities, others on the dairy temperament of their herd. In general, however, the Milking Shorthorn differs from the beef-type Shorthorn chiefly in form, fleshing, and udder. The Milking Shorthorns are somewhat more upstanding, angular in appearance, and have a longer neck and body. Dry cows put on flesh rapidly but lose their flesh when in milk. The udders are usually large and shapely and have better teat placement than is found in the beef-type Shorthorns.

Milking Shorthorns have long been favorites on many farms hroughout the United States. This is especially true of the iedium-sized herds in which the owner does not want to make specialty of either dairy or beef production. Furthermore, Milk-ig Shorthorns lend a certain flexibility that many owners desire —when milk prices are good, the production program can be hifted accordingly; and on the other hand, when economic con-



Fig. 149. Pansy (A.R.), Red Poll cow. Highest milk record: 12,057 ounds of milk; 490.1 pounds fat. Winner of 7 Grand Champions. As the ame indicates, cattle of this breed are red in color and polled. (Courtesy, ed Poll Cattle Club of America.)

itions favor beef production, emphasis may be placed on meat roduction. When the animals are no longer valuable as milkers, ney can be fattened out and sold to advantage.

Many notable production records have been made by Milking horthorns. On April 7, 1939, "Cherry," a non-pedigreed Dairy horthorn cow in England, completed a record of 41,644.5 pounds f milk. The Milking Shorthorn is the most popular milk-pro-ucing breed in England.

he Red Poll

In America, the Red Poll breed has always been in the hands f the farmer. The greatest numbers are found in the Mississippi alley.

ORIGIN AND NATIVE HOME:

The Red Poll breed of dual-purpose cattle had its origin in the counties of Norfolk and Suffolk, in the eastern middle-coastal section of England. The country is low and flat, and the soil is not too fertile.

The breed is a result of crossing horned Norfolk cattle with polled Suffolk cattle. The Norfolks were noted for their good fleshing qualities and beef type, whereas the Suffolks were bred for milk production. Little is known of the origin of Norfolk and Suffolk cattle.

EARLY AMERICAN IMPORTATIONS:

The first recorded American importation of Red Poll cattle for breeding purposes was made by G. F. Faber, of New York, in 1873. Faber made later importations, and soon other men joined him in quest of representatives of the breed.

RED POLL CHARACTERISTICS:

As the name indicates, cattle of this breed are red in color and polled. The color varies from light to dark red, the latter being preferred. The breed is considered as of medium size.

Representative animals present the dual-purpose type in its truest form. The cows are capable of producing comparatively large quantities of milk, and the calves which are evenly fleshed and smooth, fatten into desirable beef animals. As in other dual-purpose breeds, the Red Poll has not experienced the uniformity of type that exists in the strictly dairy or beef breeds. This has been due to the variation in ideals among breeders and judges.

CHAPTER XI

STABLISHING THE HERD; SELECTING AND JUDGING BEEF CATTLE

The great livestock shows throughout the land have exerted powerful influence in molding animal types. At the same time, roducers are ever aware of market demands as influenced by nsumer preferences. It must be realized, however, that only a mparatively few animals on the farms and ranches are subcted annually to the scrutiny of experienced show-ring judges market specialists. Rather, the vast majority of purebred nimals and practically all commercial herds and flocks are evaluted by practical stockmen—men who select their own foundation replacement stock and conduct their own culling operations. general, these men are intensely practical; no animals meet ith their favor unless they carry value in marketable products.

Such stockmen have no interest in the so-called breed fancy oints. These practical operators may not be able to express uently their reasons for selecting certain animals while culling thers, but usually they become quite deft in their evaluations. Whether young animals are being raised for market or for breedg stock, successful livestock operators are generally good dges of livestock.

ACTORS TO CONSIDER IN ESTABLISHING THE HERD

Except for the comparatively few persons who keep animals erely as a hobby, farmers and ranchers raise stock because, ver a period of years, it has proved to be a profitable enterprise rovided that the production and marketing phases are conducted an enlightened and intelligent manner. Therefore, after it has een ascertained that the farm, feeds, and available labor are dapted to animal production and that suitable potential markets xist, the next assignment is that of establishing a herd that efficient from the standpoint of production and that meets arket demands.

urebreds or Grades

Many breeders will continue to produce purebred stock, but ne majority of cattle producers will, for a long time to come,

produce grade stock for market rather than purebreds. Such a system requires less outlay of cash, and less experience on the part of the producer. However, even with this type of production, grading up of the herd through the use of purebred sires is always advocated.

After some experience, the commercial breeder who has handled grade cattle may add a few purebred cows to the herd and gradually build into purebreds, provided that his experience and his market for seed stock justifies the development of this type of production.

For the man with experience and adequate capital, the breeding of purebreds may offer unlimited opportunities. It has well been said that honor, fame, and fortune are all within the realm of possible realization, but it should also be added that only a few achieve this high calling.

During recent years, many successful industrialists have, as a hobby, established purebred herds of various classes of livestock. Ordinarily these men possess great ability, but they are inexperienced in the handling of animals. Such men are likely to derive more enjoyment from the venture and make a greater contribution to the livestock industry at less cost to themselves if they can be persuaded to (1) hire a competent manager in whom they have confidence and give him considerable freedom in the operation of the livestock enterprise and (2) start with the best animals obtainable and adhere to a sound breeding program.

Selection of the Breed

No one breed of cattle can be said to excel all others in all points of beef production for all conditions. The selection of a particular breed is most often a matter of personal preference, and usually the breed that the individual cattleman likes is the one with which he will have the greatest success. Where no definite preference exists, however, it is well to choose the breed that is most popular in the community—if any one breed predominates. If this procedure is followed, it is often possible to arrange for an exchange of animals, especially bulls. Moreover, if a given community is noted for producing good cattle of a particular breed, there are many advantages from the standpoint of advertisement and sales—this applies to both purebreds and grades. Above all, it should be remembered that *usually there is more difference among individuals within the same breed than between the different breeds.*

In selecting a purebred bull for a grade herd, the breed osen should usually be one that the character of the cows most arly approaches.

e of the Herd

No minimum or maximum figures can be given as to the best e for the herd. Rather, each case is one for individual consid-ation. It is to be pointed out, however, that labor costs differ ry little whether the herd numbers ten or eighty. The cost of rchasing and maintaining a herd bull also comes rather high en too few females are kept. The extent and carrying capacity the pasture, the amount of hay and other roughage produced, d the facilities for wintering stock are factors that should be nsidered in determining the size of herd for a particular farm it. The system of disposing of the young stock will also be an luencing factor. For example, if the calves are disposed of at aning time or fattened as baby beef, practically no cattle other an the breeding herd are maintained. On the other hand, if e calves are carried over as stockers and feeders or are fattened an older age, more feed, pasture, and shelter are required.

Then, too, whether the beef herd is to be a major or minor terprise will have to be decided upon. Here again, each case is e for individual consideration. In most instances, replacements ould be made from heifers raised on the farm.

iformity

In order to produce uniform calves, it is necessary that the w herd be of similar type and breeding. This applies to both e purebred and grade herd. When this rule is followed, the rd bull can be selected with more intelligence. Secondly, uni-rm offspring sell at a premium at any age, whether they are d as purebreds for foundation stock, as stocker and feeder ves, or as fat steers.

alth

All animals selected should be in a thrifty, vigorous condi-n and free from diseases and parasites. They should give every idence of a life of usefulness ahead of them. The cows should pear capable of producing good calves, and the bull should be le to withstand a normal breeding season. Tests should be ade to make certain of freedom from both tuberculosis and ntagious abortion. In fact, all purchases should be made sub-ct to the animals being free from these contagious diseases.

With costly purebred animals, a health certificate should be furnished by a licensed veterinarian. Newly acquired animals should be isolated for several days before being turned with the rest of the herd.

Condition

Although an extremely thin and emaciated condition, which may mar reproduction, is to be avoided, it must be remembered that an overfat condition may be equally harmful from the standpoint of reproduction.

It takes a unique ability to project the effect of feeding a few hundred pounds of grain or hay to a thin animal, and fortunate indeed is the stockman who possesses this quality. This applies alike to both the purebred and the commercial producer. In fact, it is probably of greater importance with the commercial cattleman, for replacement females and stocker and feeder steers are usually in very average condition.

Age and Longevity

In establishing the herd, it is usually advisable to purchase a large proportion of mature cows (cows four to eight years of age) that have a record of producing uniformly high-quality calves. Perhaps it can be said that not over one-half of the newly founded herd should consist of untried heifers. Aside from the fact that some of the heifers may prove to be non-breeders, they require more assistance during calving time than is necessary with older cows. Perhaps the best buy of all, when they are available, consists of buying cows with promising calves at their side and which are rebred to a good bull, a three-in-one proposition.

Once the herd has been established, the replacements should be made from the top heifers raised on the farm. Old cows, irregular breeders, and poor milkers sell to best advantage before they become thin and "shelly."

A sound practice in buying a bull is to seek one of serviceable age that is known to have sired desirable calves—a "proved" sire. However, with limited capital, it may be necessary to consider the purchase of a younger bull. Usually a wider selection is afforded with the latter procedure, and, also, such an individual has a longer life of usefulness ahead. Naturally, the time and number of services demanded of the bull will have considerable bearing on the age of the animal selected.

Since most beef females do not reproduce until they are proximately three years of age, their regular and prolonged production thereafter has an important bearing upon the erhead cost of developing breeding stock in relation to the mber of calves produced. The longer the good, proved, produc- cows can be kept without sacrifice of the calf crop or too ich decrease in salvage value, the less the percentage replace- nt required. Moreover, the proportion of younger animals that n be marketed is correspondingly increased. The average age discarding purebred breeding females appears to vary from ne to twelve years, with commercial cattle being marketed at o to three years younger ages. Selection and improvement in gevity are possible in all breeds and should receive more ention.

productive Ability

It is estimated that, for the United States as a whole, out of ch one hundred cows bred only 63 per cent drop calves annu- y. The other 37 per cent are nonproducers, either temporarily permanently. Many of the southern states have even lower f crop percentages, some state averages running as low as 50 cent. With a 50-per-cent calf crop, it simply means that two ws are being maintained an entire year for the production of e calf. As reproductive ability is fundamental to economical ef production, it can be readily understood that sterility con- tutes a major annual loss in the cattle business. In fact, cattle- n acknowledge that the calf crop percentage is the biggest gle factor affecting profit in beef cattle production.[1] Improper eding and disease are the two most common causes of low rcentage calf crops in cattle.

Overfeeding, accompanied by extremely high condition, or derfeeding, accompanied by an emaciated and run-down condi- n, usually result in temporary sterility that may persist until e condition is corrected. Lack of exercise, inflammation and fection of the reproductive tract resulting from retained after- th or other difficulties encountered at calving, and infections various other kinds may also result in temporary sterility. The

[1]Methods of computing calf crop percentages vary, but the three most mmon methods are: (1) number of calves born in comparison to the num- of cows of breeding age, (2) number of calves marketed or branded in ation to the cows of breeding age, and (3) the number of calves that reach aning age as compared to the number of breeding cows. Perhaps the first thod is the proper and most scientific one, but, for convenience reasons, st ranches use the second method.

most common causes of permanent sterility in cattle are: old age; diseased reproductive organs, such as cystic ovaries; diseased fallopian tubes; and heredity. The reproductive ability of an individual or an entire herd may also be greatly affected, either temporarily or permanently, by the presence of brucellosis.

Sterility may be present in either sex. Occasionally bulls are sterile even though sexually active. Differences in the fertility of bulls are especially revealed by the records kept and the semen studies made in artificial insemination.

In addition to the above factors affecting reproduction, the percentage calf crop may be affected by the proportion of bulls to cows, their distribution on the range, and the season of breeding.

Milking Ability

Most commercial cattle producers have long recognized the importance of good milking cows in producing heavy, thrifty calves. Unfortunately, insufficient attention is given to this factor by altogether too many purebred breeders. Instead, they have come to rely upon nurse cows for supplemental milk.

Beef cows that do not produce sufficient milk to raise their own calves satisfactorily should be culled from the herd. One can soon improve the milking ability of the herd by giving proper attention to this factor when selecting the herd bull. The best method is to select a bull whose sire and dam have both produced good milking daughters. If there is no opportunity to observe or to secure information on the daughters of the parent animals, then the milking ability of the mother and of the sire's mother is the next best criterion. Even though good milking ability is desired, an excessive flow of milk in commercial cattle is equally undesirable, for it results in difficulty in milking them out and many spoiled udders.

Size

The question of size of beef cattle has been a point of considerable controversy among beef cattle producers. Fashions in beef cattle type have gradually changed during the past fifty or sixty years, moving from the big, rugged, beefy—but oftentimes rough "farmer or rancher type" that our grandfathers produced—to the smaller, earlier-maturing, blockier, smoother types in vogue today, of which the so-called "comprest" or "compact" represent the extreme. (These extremes are known as "comprests" in Herefords and "compacts" in Shorthorns.)

The reasons for this change in cattle type are many and ried, but perhaps the new types have been due principally to e demand on the part of the consumer for smaller cuts of meat. ie show ring has likewise been an important factor, and show- ig fashions for both the finished product and breeding animals ve tended to follow consumer preferences.

Unfortunately, the tremendously important utility factor or onomy of production has been largely overlooked in this shift, d little information is available in regard to whether the naller types can be produced as economically as larger cattle. any producers feel that bigger cattle can be produced the most onomically, especially under conditions where operating costs e on a "per-head" rather than a "per-pound" basis and where ofit in a cattle enterprise depends primarily upon the ability of e animals to utilize efficiently large amounts of roughage. The inion is also prevalent that show-ring fashions toward the low- t, blocky, earlier-maturing types have gone further than con- mer demand justifies and that the result has been the develop- ent of small "pony-type" cattle that the packing industry can- t absorb at profitable prices in any numbers.

Fortunately some experimental work, designed to answer ese and other questions, is now underway. In 1950 reports— vering studies involving large, intermediate, and small type ereford cattle—Stonaker of the Colorado Station indicated the llowing: (1) Small type steers consumed less feed per day and ade smaller daily gains than steers in either of the other roups; (2) there was no great difference in the efficiency of ed utilization of the steers, each group producing about the me gain for each pound of feed consumed; (3) during the inter months, the roughage (hay) consumption of the breeding ws in each group was proportional to their respective body eights; that is, the larger the animal the greater the hay con- mption, and (4) the percentage of wholesale meat cuts were out the same in the carcasses of small and conventional type eers.

In the Colorado experiments, all groups of steers were fed to out the same degree of finish. This is important because fat is igh in energy; and the fatter an animal becomes the less ef- ciently it utilizes its feed. Thus it stands to reason that smaller- pe animals, when fed to the same weight as large-type animals, ill be fatter and therefore will require more feed per hundred ounds gain.

Perhaps, in the final analysis, the most practical size of cattle will vary according to: (1) the type and plane of nutrition available and (2) whether or not the market is a critical one. Thus, if large acreages of range are to be utilized and it is desired to market the cattle as heavy steers (about 1,200-pound weights) —as either grass-fat steers or with a minimum of grain feeding—perhaps the large-type animals would be preferable. It must also be remembered that the labor costs under range conditions are no greater for handling large animals with their greater pounds than they are for the small animals.

On the other hand, under conditions where the available area is smaller, where a greater quantity of grain and less roughage is produced, and the market is a discriminating one in which the consumers desire high quality but smaller cuts of meat, the situation may favor the production of smaller-type cattle.

Certainly animals can be too big. Huge size is usually accompanied by coarseness, poor fleshing qualities, loose rather than compact conformation, and slow maturity and fattening. Perhaps, under most conditions and in the final analysis, medium-type cattle are best from the standpoint of widest adaptability, general vigor, reproductive efficiency, milk production, longevity, and marketability. Yet it is reasonable to conjecture that there are environmental and market conditions under which one or the other extremes in beef type (the large type or the small type) may be more profitable.

Adaptation

As has already been indicated—except in those localities where a certain breed greatly predominates, thus making possible the exchange of breeding stock and joint benefits in selling surplus stock—one will usually do best to select that breed for which the producer may have a decided preference. On the other hand, there are certain areas and conditions wherein the adaptation of the breed or class of animals should be given consideration. For example, in the Southwest, the crossing of Brahmans on Shorthorns has produced the Santa Gertrudis breed of cattle, an American creation which seems to thrive despite the extreme heat, heavy insect infestation, and less abundant vegetation common to the area.

The livestock producer must always breed for a strong constitution—the power to live and thrive under the adverse conditions to which most animals are subjected sometime during their lifetime. Under natural conditions, selection occurs for this

aracteristic by the elimination of the unfit. In domestic herds d flocks, however, the constitution of foundation or replace- nt animals should receive primary consideration.

ice

With a grade herd, it is seldom necessary to pay much in cess of market prices for the cows. However, additional money id for a superior bull, as compared to a mediocre sire, is always good investment. In fact, a poor bull is high at any price. With e purebred breeder, the matter of price for foundation stock is e of considerable importance. Though higher prices can be stified in the purebred business, sound judgment should always evail.

ELECTION AND ITS BASES

In simple terms, selection in livestock breeding is an attempt secure or retain the best of those animals in the current gen- ation as parents of the next generation. Obviously, the skill ith which selections are made is all-important in determining e future of the herd or flock. It becomes perfectly clear, there- re, that the destiny of breed improvement is dependent upon e selection for breeding purposes of those animals which are netically superior. The use of genetically inferior animals for eeding purposes has ruined many a herd.

The profitability of any individual animal or of a herd or ck of animals is determined by the following two factors:

1. **Type or individuality** based upon the ability to produce igh-quality products for a discriminating market.

2. **Performance or efficiency of production,** which is the bility to utilize feed efficiently in producing meat, milk, wool, nd power. This also includes the ability to reproduce regularly nd to produce large litters in the case of litter-bearing animals.

Three bases of selection are at the disposal of the livestock roducer: (1) selection based on pedigree, (2) selection based on how-ring winnings, and (3) selection based on production test- ng. Perhaps at the outset it should be emphasized that each ethod of selection has its own particular place. Certainly the rogressive cattleman will make judicious use of all of them.

election Based On Type or Individuality

The ultimate objective in beef production is that of selling neat over the block. Thus fads or fancies in beef cattle selection

that stray too far from this objective will, sooner or later, bring discredit and a penalty.

Strictly from the standpoint of the packer and the consumer, a meat animal should produce the maximum of the high-priced cuts, and there should be a very minimum of the less valuable bones and internal organs. On the other hand, in order to obtain efficiency of production under practical farm or ranch conditions, the producer must have animals with fairly good bone and a good middle. When such points of conflict exist, there must be a compromise. The most profitable beef animals, therefore, will be those that strike a happy balance between type, as related to the maximum production of a high-quality product, and the efficiency of production of this product.

Although environmental factors have a tremendous influence on animals, the fact remains that the performance and type of the animal itself (its phenotype or how it looks) are the best single indicators of the germ plasm that it carries (its genotype or what it actually is). Performance and type, therefore, are the most useful single factors in making selections. Naturally, this applies only to those characteristics that the animal itself can express. From a practical standpoint, this means that only those animals which are themselves average or preferably better than average should be used for breeding purposes, irrespective of the merit of near relatives.

The selection of animals on the basis of type or appearance alone is commonly called mass selection. This is the usual procedure followed in commercial herds, and, in a large part, it is responsible for the transformation of the Texas Longhorn to the present-day prime bullock.

In making selections based on type or individuality, it must be remembered that the characteristics found in the breeding herd are very likely to be reflected in the offspring; for here, as in any breeding program, a fundamental principle is that "like tends to produce like." Then, too, one must not overlook the fact that the herd bull is far more than half of the herd. A cow's inheritance will only influence one calf a year; whereas the herd bull may influence twenty to fifty times as many individuals in a given season.

Selection Based On Pedigree

In pedigree selection, the individuality and performance of the ancestors are relied upon for an estimate of the probable transmitting ability. This method is used in most purebred herds.

Pedigree selection is of special importance when progeny rformance data is not available or when the animals are either thin or so young that their individual merit cannot be ascer-ined with any degree of certainty. When selection is being ade between animals of comparable individual merit, the pedi-ree may be the determining factor.

In making use of pedigree selections, however, it must be membered that the ancestors close up in the pedigree are much ore important than those many generations removed. Likewise, ne must not be misled nor must he overestimate the value of mily names or favorite animals many generations removed om the foundation animal. Pedigree fads as such should be oided, especially if there has not also been rigid culling and lection based on utility value. In all instances, poor individuals ould not be saved, regardless of the excellence of relatives.

lection Based On Show-Ring Winnings

The show ring has long been a major force in shaping the pe of all classes of livestock. The first American show was held Pittsfield, Massachusetts, in 1810, but livestock exhibitions ad been initiated in Europe many years earlier.

As now conducted, our livestock shows have both advantages nd disadvantages from the standpoint of breed improvement. mong the advantages are the following:

1. The show ring is the best medium yet discovered for olding breed type. For this reason, it behooves the breed reg-try associations and the purebred breeders alike to accept their ghtful responsibility in seeing that the animals which win top onors are those that most nearly meet the efficiency of produc-on demands on the part of the producer and the meat quality emands of the consumer.

2. It serves as one of the very best advertising or promo-onal mediums for both the breed and the breeder.

3. It brings breeders together for exchange of ideas and xperiences.

4. It provides an incentive to breed better cattle, for only by omparing animals in the show ring can the breeder ascertain hether or not he is keeping up with his competitors.

Some of the disadvantages of the show ring are as follows:

1. Heavy fitting, in order to win, often results in temporary r permanent sterility.

2. The desire to win often causes exhibitors to resort to "surgical means" and "filling" in order to correct defects. Admittedly, such man-made corrections are not hereditary, and their effects are often not too durable—as is belatedly discovered by some innocent purchaser.

3. Valuable animals are frequently kept out of productive work or from reproduction in order to enhance their likelihood of winning in the show ring.

Thus, in making selections from among show animals, one should do so with a full understanding of both the virtues and the limitations therein.

Selection Based on Production Testing

As pointed out in Chapter II, production testing is the most infallible basis of selection. Further details relative to the traits of importance in beef cattle and the method of measuring each are presented in Chapter XIII.

Progressive cattle breeders are beginning to select bulls backed by either an individual merit test or progeny test. This interest will increase. The far-seeing purebred breeder, therefore, will start now to get his herd on a tested basis. It should be emphasized, however, that even though production testing is one of the keenest tools available to the breeder, for best results it is advocated that one continue to use all four methods of selection: individuality, pedigree, show ring, and production testing. But increasing emphasis should be placed upon the latter method. In other words, production testing should be used to supplement individual, pedigree, and show-ring selection rather than to replace them as is sometimes advocated.

HERD IMPROVEMENT THROUGH SELECTION

Once the herd has been established, the primary objective should be to so improve it as to obtain the maximum production of quality offspring. In order to accomplish this, there must be constant culling and careful selection of replacements. The breeders who have been most constructive in such a breeding program have usually used great breeding bulls and then have obtained their replacements by selecting some of the outstanding, early-maturing heifers from the more prolific families.

Improvements through selection are really twofold: (1) the immediate gain in increased calf production from the better animals that are retained, and (2) the genetic gain in the next

neration. The first is important in all herds, whereas the sec-
d is of special importance in purebred herds and in all herds
here replacement females are raised. Most of the immediate
in is attained in selecting the cows, which are more numerous
an the bulls; whereas the majority of the genetic gain comes
om the careful selection of bulls. The genetic gain is small, but
is permanent and can be considered a capital investment.

Many good cattle breeders consider it a sound practice to
an on a 10 to 15 per cent replacement each year. Under such a
stem of management ten to fifteen heifer calves are retained
ch year for each one hundred cows.

JDGING BEEF CATTLE

The discussion that follows represents a further elucidation
the first point discussed under selection—individuality. In
dition to individual merit, the word "judging" implies the com-
rative appraisal or placing of several animals.

Judging beef cattle, like all livestock judging, is an art, the
diments of which must be obtained through patient study and
ng practice. The master breeders throughout the years have
en competent livestock judges. Shrewd traders have also been
asters of the art, even to the point of deception. The essential
ualifications that a good judge of any class of stock must pos-
ss may be summarized as follows:

1. **A clearly defined ideal or standard of perfection** for each
the distinct types and breeds being judged and a knowledge
the relationship of type to performance. This first necessitates
knowledge of the different parts of an animal.

2. **Keen observation and sound judgment.** The good judge
ossesses keen ability to observe both good conformation and
efects, and he must make accurate comparisons and reach log-
al conclusions. That is, there must be knowledge of the relative
nportance of the various features, both good and bad.

3. **Honesty and courage.** The good judge of any class of
vestock must possess honesty and courage, whether it be in
aking a show-ring placing or conducting a breeding program.
or example, it often requires considerable courage to place a
ass of animals without regard to: (1) placings in previous
nows, (2) ownership, and (3) public applause. It may take even
reater courage and honesty with oneself to discard from the
erd a costly animal whose progeny has failed to measure up.

4. **Logical procedure in evaluating.** There is always great danger of the beginner making too close an inspection; he oftentimes gets "so close to the forest that he fails to see the trees." Good judging procedure consists of the following three single steps: (1) observing at a distance and securing a panoramic view where several animals are involved, (2) using close inspection, and (3) moving the animal in order to observe action.

Parts of a Cow

The first step in preparation for judging beef cattle consists of mastering the language that describes and locates the different parts of the animal. This information is set forth in Figure 150. Also, it is necessary to know which of these parts constitute items of major importance; that is, what comparative evalua-

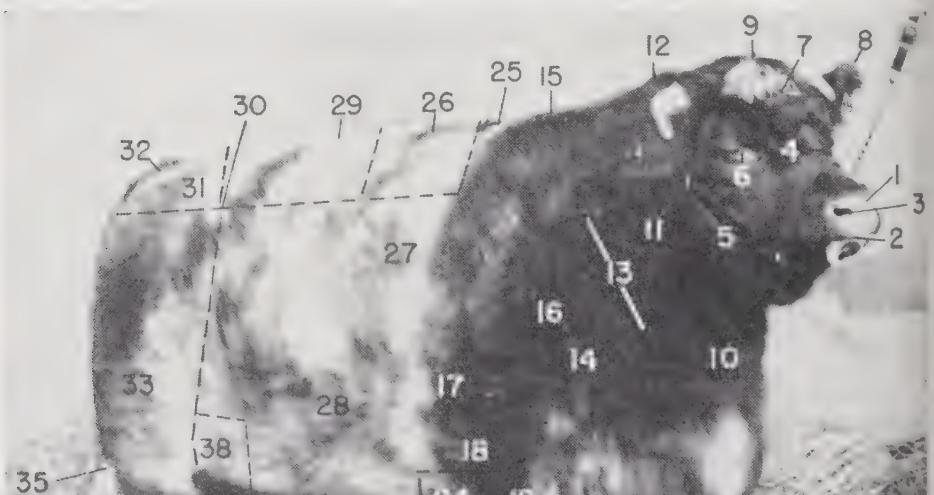


Fig. 150. Parts of a steer. The first step in preparation for judging beef cattle consists of mastering the language that describes and locates the different parts of the animal. (The above Shorthorn steer was Grand Champion over all breeds at the 1947 Chicago International. Shown by Claude Millvel, Ft. Cobb, Oklahoma.)

1. Muzzle
2. Mouth
3. Nostril
4. Face
5. Jaw
6. Eye
7. Forehead
8. Ear
9. Poll
10. Dewlap
11. Neck
12. Crest
13. Shoulder vein
14. Point of shoulder
15. Top of shoulder
16. Shoulder
17. Foreribs or heart girth
18. Elbow
19. Arm
20. Knee
21. Shank
22. Foot
23. Dew claw
24. Fore flank
25. Crops
26. Back
27. Ribs
28. Belly
29. Loin
30. Hip or hook
31. Rump
32. Tail-head
33. Thigh
34. Hock
35. Tail
36. Switch
37. Cod
38. Rear flank

n should be given to different parts of the animal? Having quired this knowledge, long hours must be spent in patient dy and practice in comparing animals. Even this will not make pert and proficient judges in all instances, for there may be a ain of truth in the statement that "the best judges are born d not made." Nevertheless, training in judging and selecting

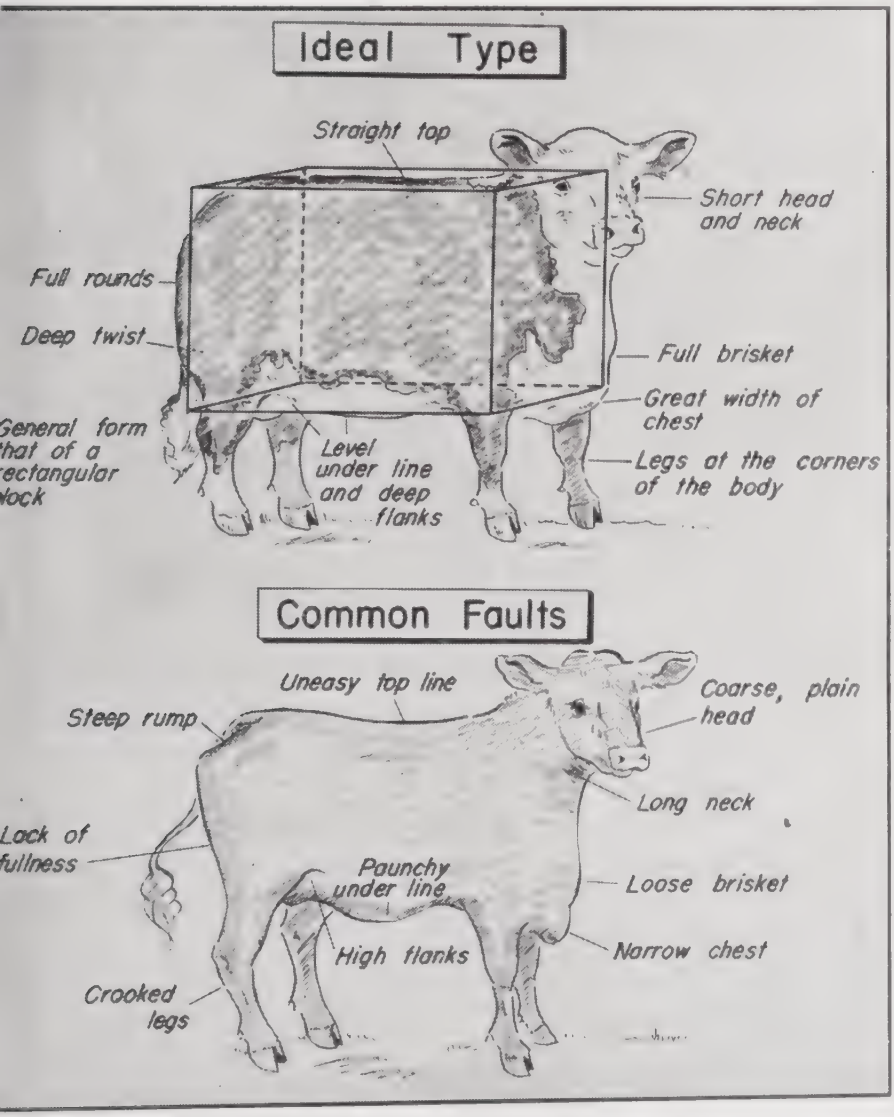


Fig. 151. Ideal beef type versus common faults. After mastering the guage that describes and locates the different parts of an animal, the t requisite in judging is to have clearly in mind a standard or ideal. brief, the successful beef cattle judge must know what he is looking for, l be able to recognize and appraise the common faults. (Drawing by R. Johnson.)

animals is effective when directed by a competent instructor or experienced stockman.

Ideal Beef Type and Conformation

The next requisite in judging is to have clearly in mind a standard or ideal. Presumably, this ideal should be based on a combination of: (1) the efficient performance of the animal from the standpoint of the producer and (2) the desirable carcass characteristics of market animals as determined by the consumer.

With beef animals, type is measured by the relative proportions between rounds, loins, ribs, shoulders, chucks, legs, and other cuts as well as by the estimated quality and the dressing percentage of the animal. The ideal beef animal should be low set and compact. The body should have great width and depth throughout, with good lines, and with all parts smoothly blended together. The animal should be thickly and evenly fleshed, with superior development in the regions of the high-priced cuts. The legs should be straight, true, and squarely set; the bone should be ample and show plenty of quality. With this splendid beef type, there should be style, balance, and symmetry and an abundance of quality. Beef cows should show femininity and breediness. The bull should show great masculinity. He should be burly, bold, and rugged and have an energetic yet manageable disposition. The great breeders of the past were men who visualized an ideal better than the current standards and who were not stampeded by passing fads. They possessed both a goal and a program.

It must be recognized, however, that the perfect specimen has never been produced. Each animal possesses one or several faults. In appraising an individual animal, therefore, its good points and its faults must be recognized, weighed, and evaluated in terms of an imaginary ideal. In comparative judging—that is, in judging a class of animals—the good points and the faults of each animal must be compared with the good points and the faults of every other animal in the class. In no other manner can they be ranked.

In addition to recognizing the strong and weak points in an animal, it is necessary that the successful judge recognize the degree to which the given points are good or bad. A sound evaluation of this kind requires patient study and long experience. Figure 151 shows the ideal beef type versus some of the common faults.

ethod of Examining

As in examining any class of livestock, in judging beef cattle e examination should be systematic and thorough. First, the imal (or animals) should be viewed from a distance, obtaining ews from the side, rear, and front. Finally, the animal should handled.

It makes little difference as to the order of the views in specting cattle, but it is important that the same procedure followed each time. Though good judges differ, perhaps as gical a method of examining as any is illustrated in figure 152.

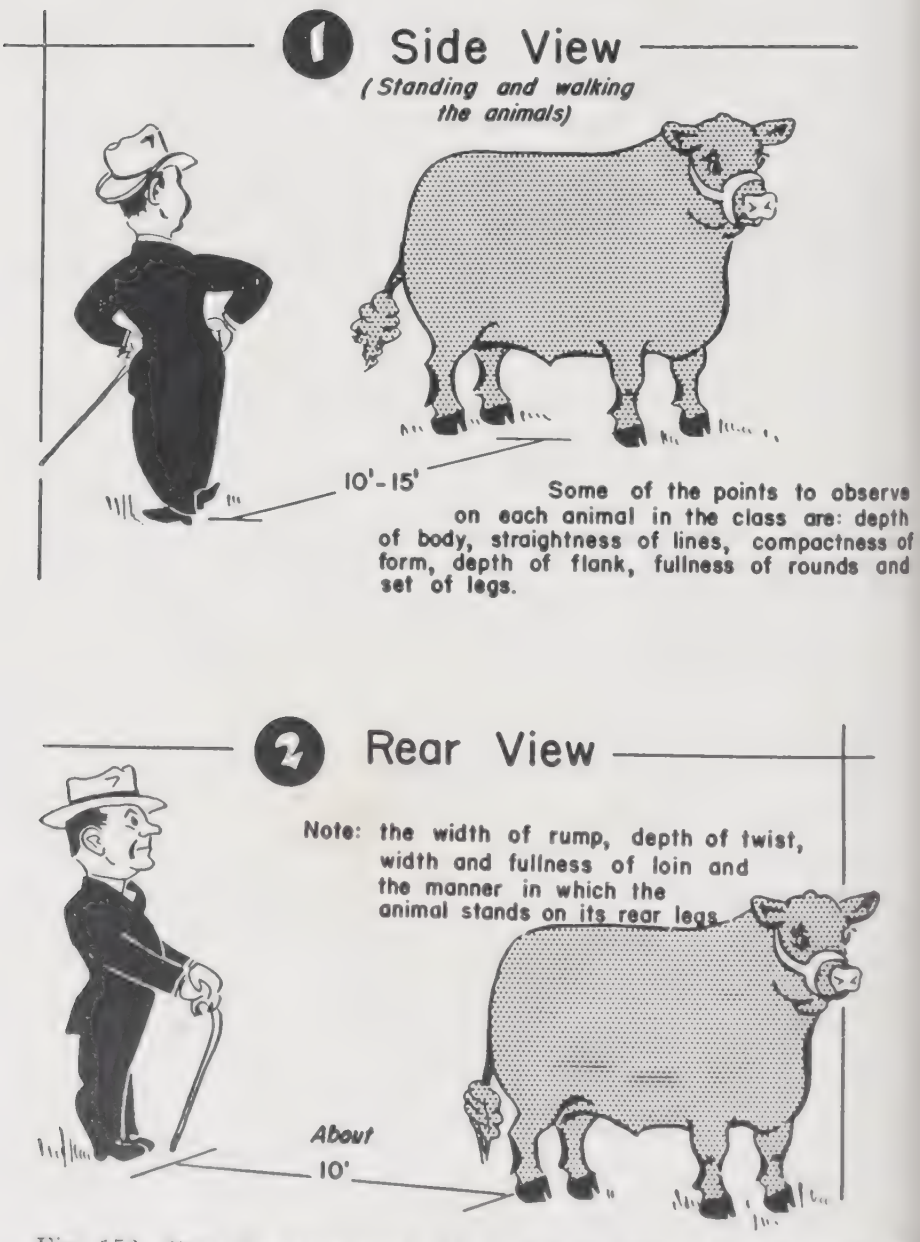
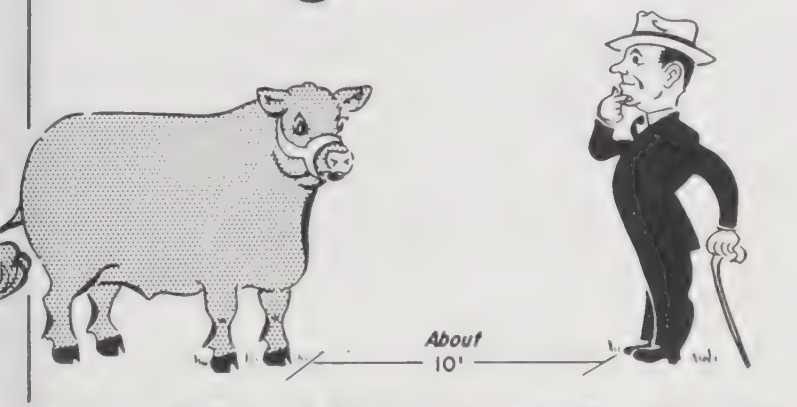


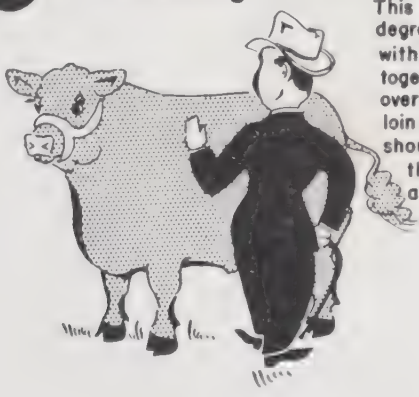
Fig. 152. Steps in examining: (1) side view, and (2) rear view; (3) front view, and (4) handling. It is important that the judge follow a logical procedure in looking over animals. (Drawing by R. F. Johnson.)

3 Front View



Study each animal's: head features and characteristics, spring of rib, width of chest and set and bone of forelegs.

4 Handling



This last step is to determine degree and quality of finish: with palm down, fingers held together feel the animals over upper and lower ribs, loin edge and top line from shoulder to rump. With thumb and fingers catch a roll of hide to test its pliability.

CHAPTER XII

SYSTEMS OF BEEF PRODUCTION

The general systems of beef production that are most extensively practiced include: (1) breeding purebreds; (2) production of stockers and feeders; (3) growing of stockers; (4) baby beef production; (5) fattening cattle; and (6) dual-purpose production. In these systems, two area methods of management are involved: the farm herd method and the range cattle method.

BREEDING PUREBREDS

This is a specialized type of production. Generally speaking, only the experienced breeder should undertake the production of purebreds with the intention of furnishing foundation replacement stock to other purebred breeders, or purebred bulls to the



Fig. 153. Purebred Hereford herd on pasture at Hillcrest Farm, Chester, West Virginia. The breeding of purebreds is a highly specialized type of production. (Courtesy, F. A. Livesay, West Virginia University.)



Fig. 154. Cow-and-calf system of beef cattle production on the Black nch, Brewster, Nebraska. In this system, the calves are run with their ns until weaned and none of the cows are milked. It is the most common tem of beef production on the western range. (Courtesy, C. B. & Q. Rail- d Co.)

mmercial producer. Unless prices are unusually favorable, the ginner had best start with grade cows and a purebred bull. though there have been many constructive beef cattle breeders d great progress has been made, it must be remembered that ly those "master breeders" like Bakewell, Cruickshank, and ntry are among the immortals. Few breeders achieve the suc- ss which was theirs.

It is estimated that only 3 per cent of the cattle of the ited States are purebreds at the present time and that more an 88 per cent of the farms on which beef cattle are kept do t possess a single purebred beast. Although limited in numbers, rebred herds are scattered throughout the United States and clude both farm and ranch operations.

RODUCTION OF STOCKERS AND FEEDERS

Production of stockers and feeders is sometimes referred as the "cow-and-calf system" of beef cattle production. In this stem the calves run with their dams until weaned, and none of e cows are milked. This particular type of production is fol- ved more extensively than any other throughout the United ates. It is especially adapted to regions where pasture is plenti- and land is cheap. As might be expected, it represents the re or less standard system of beef production in the western nge country. The breeding herd needs but little grain or other pensive feeds, except when the ground is covered with snow.

GROWING OF STOCKERS

Stockers are young animals that are being fed and cared for in such a manner that growth rather than improvement in condition is the main objective. They may consist of steers or heifers that are intended for fattening purposes at a later period, or heifers which will be used for breeding purposes. Usually such cattle are not held longer than a year, and for the most part, they are fed chiefly on pasture and cheap roughage. This type of operation is conducted in both the farm and range states.



Fig. 155. Hereford steers being fattened by Frank Friedricksen, Andover, Iowa. The grain fattening of cattle is confined almost entirely to the Corn Belt, with some concentration in the irrigated valleys of the West. (Courtesy, The Corn Belt Farm Dailies.)

BABY BEEF PRODUCTION

"Baby beef" is the term applied to finished animals from twelve to eighteen months of age, that weigh 700 to 1,200 pounds, and which grade from "Good" to "Prime." In its truest form, the production of baby beeves implies the breeding, rearing, and fattening of the calves on the same farm. The first requirement for baby beef production is superior breeding. Secondly, the calves intended for such use should never be allowed to lose their baby fat. Ordinarily the calves are "creep fed"—grain is placed before them as soon as they are old enough to eat, usually when they are from four to six weeks old. Cows producing calves intended for baby beef are generally fed a little more liberally than those producing calves for other purposes.

Well-finished baby beeves command top prices, and the demand is wide and insistent. An increasing number of beef men are therefore turning their efforts to this type of production. Boys and girls 4-H Club work has done much to focus attention on baby beef production.

THE FATTENING OF CATTLE

The cattle-fattening industry, in so far as grain feeding is concerned, is confined almost entirely to the Corn Belt, with some concentration in the irrigated valleys of the West. Although



Fig. 156. Red Poll steers on feed. Dual-purpose cattle provide considerable flexibility. Thus, when labor is scarce and dairy products are low in price, the emphasis may be placed on beef production. (Courtesy, Red Poll Cattle Club of America.)

some of the central states feeders maintain breeding herds from which they produce their own feeder calves, the majority of feeders continue to rely on the western ranges for their young stock.

For the inexperienced feeder or the "in-and-outer," this type of production is surrounded by many hazards. When feeders have the opinion that profits are due largely to clever buying and selling, the enterprise is often a "gamble." However, for the man who follows cattle feeding year after year as a method of marketing home-grown grain, who practices skillful feeding and management, and who conserves the manure as fertilizer, this system will give good returns over a period of years. The subject of fattening cattle is more fully discussed in Chapter XIV.

DUAL-PURPOSE PRODUCTION

For the most part, dual-purpose production has been confined to the small farmer who lives upon the land and who makes his living therefrom. Cows of dual-purpose breeding are often referred to as the "farmer's cow." In this type of production, an attempt is made to obtain simultaneously as much beef and milk as possible. That is to say, in its truest form, this type of management can be classified as neither beef nor dairy production.



Fig. 157. A farm herd of beef cattle. In general, farm herds are much smaller than range herds. Moreover, beef production in the farm states is usually part of a diversified type of farming. (Courtesy, Purdue University.)

One of the chief values of dual-purpose production lies in its flexibility of management. When labor is available and dairy products are high in price, the herd may be managed for market milk production. On the other hand, when labor is scarce and dairy products are low in price, calves may be left running with their dams, and emphasis may be placed on beef production.

THE FARM HERD METHOD

In general, beef cattle production in the so-called farm states is merely part of a diversified type of farming. Grain and pasture crops are produced; and on the same farm, beef cattle may compete with dairy cattle, hogs, and sheep for the available feeds. This applies to practically all the farms located to the east of the seventeen western range states. In general, farm beef cattle herds are much smaller than range herds of the West, and many of them lack the uniformity which now prevails in range cattle.



Fig. 158. Hereford cattle on a range in Oregon. South Sister peak in background. (Courtesy, U. S. Forest Service.)

HE RANGE CATTLE METHOD

Fifty-eight per cent of all U. S. beef cattle are produced on e western range. Because a considerable portion of the range ea is not suited to the production of grains, and sheep offer e only other major use of the grasses, it seems evident that nge beef cattle production will continue to hold a place of ominence in American agriculture.

CHAPTER XIII

BREEDING BEEF CATTLE

Although it is true that exactly the same laws of nature govern heredity in all animals, special breeding problems are peculiar to each class of stock, and cattle are no exception.

NORMAL BREEDING HABITS OF COWS

In general, cattle that are bred when out on pasture or range are mated under environmental conditions approaching those which existed in nature prior to domestication. Less breeding trouble is generally encountered among such animals than among beef or dairy animals that are kept in confined conditions and under forced production.

Age of Puberty

Heifers generally start coming in heat soon after they reach one year of age. It is recognized, however, that the age at which puberty is attained varies according to: (1) breeds, with the smaller breeds having an earlier onset of puberty than the larger, slower maturing ones; and (2) nutritional and environmental factors, with puberty occurring when animals have reached about one-third of their adult size.

Age to Breed Heifers

The age at which to breed heifers will vary with their growth and development. However, when heifers are reasonably well grown, a safe rule is to breed at the first breeding season after they are fifteen to twenty months old. The American Hereford Cattle Breeders' Association will not register a calf dropped by a cow under twenty-four months of age at calving time. This means a minimum breeding age of fifteen months with Herefords when it is intended that the calf shall be registered.

There appears to be an increasing tendency among ranch operators to breed heifers at an earlier age. Some ranchers sort the young bred heifers out from the rest of the herd in order to provide the choicest range for them. Others use an Angus bull on young first-calf heifers, claiming that there is less trouble at calving time because of the smaller body size and smaller heads of such calves. Certainly, if the dam and the calf were not ad-

ersely affected, breeding at an early age would be advantageous om the standpoint of cutting production costs.

Based on limited experiments plus observation, the following e some of the disadvantages of allowing heifers to calve for e first time as two-year-olds:

1. It usually retards the growth of the heifers, for nature s ordained that the growth of the fetus and the lactation hich follows shall take priority over the body requirements the mother.
2. The percentage calf crop is smaller than that obtained ith older cows handled in a comparable manner.
3. The calves have a lighter birth weight.
4. There is usually a higher death loss at calving time.
5. The cows frequently do not calve again as three-year-olds.

From the above, it may be concluded that only exceptionally ell-grown and liberally fed heifers should be bred to calve as vo-year-olds. Even then, these heifers should have closer super- sion at calving time, and it is advisable that the calves be eaned at an earlier age in order to alleviate the strain of the ctation period.

For the average breeder, it is best not to have the heifers lve until they are about thirty months of age. This practice n be followed if calves are being dropped in both spring and ll. When the management practice calls for either spring or ll calving and no departure therefrom, it is necessary to have e heifers calve when either two or three years of age rather an somewhere between these limits.

eat Periods

The period of duration of heat—that is the time during hich the cow will take the bull—is very short, usually not over velve to eighteen hours, although it may vary from about six thirty hours. Cows tend to have a pattern of external be- avior; for example, they come in heat during the morning hours, o out of heat in the evening or early part of the night, and then vulate approximately fourteen hours after the end of heat.

Females of all species bred near the end of the heat period re much more likely to conceive than if bred at any other time. he heat period recurs approximately at twenty-day intervals, ut it may vary a day or two either way. In most cases, cows o not show signs of oestrum until some six to eight weeks after arturition or in some instances even longer. Occasionally, an onormal condition develops in cows that makes them remain in

heat constantly. Such animals are known as nymphomaniacs. This condition is due to the development of cysts and the failure of the follicle to rupture. Treatment, which may or may not be successful, consists of rupturing the cysts via rectum or hormone injection.

SIGNS OF OESTRUM:

Cows vary greatly in their behavior during oestrum. However, an "in-heat cow" generally exhibits one or more of the following characteristic symptoms: (1) nervousness; (2) attempts to mount other members of the herd, which in turn often mount her; (3) a noticeable swelling of the labiae of the vulva; (4) an inflamed appearance about the lips of the vulva; (5) frequent urination; and (6) a mucous discharge. Dry cows and heifers usually show a noticeable swelling or enlargement of the udder during oestrum, whereas in lactating cows a rather sharp decrease in milk production is often noted.

Gestation Period

The average gestation period of cows is 283 days, or roughly about 9½ months. Though there may be considerable breed and individual variation in the length of the gestation period, it is estimated that two-thirds of all cows will calve between 278 and 288 days after breeding.

FERTILITY IN BEEF CATTLE

Fertility refers to the ability of the male or female to produce viable germ cells capable of uniting with the germ cells of the opposite sex and of producing vigorous, living offspring. Fertility is lacking in very young animals, manifests itself first at puberty, increases for a time, then levels out, and finally recedes with the onset of senility. In cattle, as with other classes of farm animals, fertility is determined by heredity and environment.

Of course, the final test for fertility is whether young are produced, but unfortunately this test is both slow and expensive. Through evaluation of the quality of semen, it is possible to make a fairly satisfactory appraisal of the male's fertility, but no comparable measure of the female's relative fertility has yet been devised.

METHODS OF MATING

In general practice, two methods of mating beef cattle are followed, hand mating and pasture mating. Each of these will be discussed.

and Mating

In hand mating, the bull is kept separate from the cows at l times, except when an individual cow is to be bred and is rned in with him for this purpose. As a rule, in hand mating, ly a single service is allowed, the cow being removed immedi- ely after copulation. In the breeding of purebred cattle, when eeding records are so important, this method is usually fol- wed. Hand mating allows for a more accurate check on whether e bull is settling the cows. It also permits a larger number of ws to be served by a bull, an especially important consideration ith a proved sire.

asture Mating

In this system the bull is turned in with the herd, either roughout the entire year or during the breeding season. Even ith pasture breeding, when it is desired to have the calves all me within a few weeks of each other thereby assuring more niformity in size and offspring, the herd bull should be sep- rated from the cows except during the breeding season. niformity in size is very important from the standpoint of arketing the calves advantageously. Furthermore, by having ie calves come as nearly as possible at one time, closer observa- on may be given the herd at the time of parturition.

Pasture breeding is most often followed with a commercial rd. As a rule, this system requires less labor, and there is less anger of missing cows when they are in heat. However, the nvenience of pasture mating should not result in neglect to ieck whether the cows are being settled during the breeding eason.

IGNS AND TESTS OF PREGNANCY

Absence of heat is not always a sign of pregnancy, but a sitive diagnosis can be made. By about the second month in eifers and the third month in cows, the uterus becomes en- rged, especially in the pregnant horn, and drops into the ab- minal cavity. An experienced technician can ascertain this gn of pregnancy by *feeling with the hand through the rectum all.* This is the most common test of pregnancy. It is popular ecause it affords early diagnosis, and there is little hazard when erformed by experienced operators.

An internal examination for pregnancy may also be made ia the vagina, but with this method there is danger of forcing

an abortion, even when the test is performed by an experienced operator.

Other less-used tests for pregnancy in cows are:

1. **Abdominal ballottement** may be used from the fifth to the seventh months of pregnancy. This technique consists of feeling the fetus by external examination of the abdominal region. The hand or fist of the operator is held against the abdomen in the lower right flank region. By executing a short, vigorous, inward-upward thrust in this region and retaining the hand in place, the hard fetus may be felt. Because of the amniotic fluid, the technique described above will make the fetus recede, but it will fall back in place almost immediately.

2. **The fetal heart beat** can sometimes be detected after the sixth month of pregnancy, though this method is not as certain in the cow as in other classes of farm animals. Use of a stethoscope is preferred, though good results are sometimes secured by merely placing the ear against the right lower abdominal region and listening. The fetal heart beat can be distinguished from that of the mother because of its greater frequency and lighter and higher pitch.

3. **Fetal movements** can sometimes be observed through the abdominal wall during the latter half of pregnancy. This method of detecting pregnancy requires much patience. The observer simply must wait until voluntary movement of the fetus on the right side of the cow is observed. The inhuman practice of trying to induce movement of the fetus by allowing a very thirsty cow to take on a fill of cold water is to be condemned.

CARE AND MANAGEMENT OF THE BULL

Outdoor exercise throughout the year is one of the first essentials in keeping the bull virile and in a thrifty, natural condition. The finest and easiest method of providing such exercise is to arrange for a well-fenced, grassy paddock (about two acres is a good size for one bull). Many valuable sires have been ruined through close confinement in a small stall—or more likely yet—through being kept knee deep in mud within a small filthy enclosure. In addition to the valuable exercise obtained in the grassy paddock, the animal gets succulent pasture, an ideal feed for the herd bull.

A satisfactory and inexpensive shelter should be provided for the bull. The most convenient arrangement is to have this within or adjacent to the paddock, so that the bull may run in and out at will. Sufficient storage space for feed and conveniences

r caring for the bull should be provided in this building. Nor-ally, purebred bulls are kept in separate stalls and enclosures, ough some successful purebred breeders regularly run several luable bulls in one enclosure. Bulls used in commercial herds e usually run together, both on the range and when separated t from the cows. Because of their scuffling and fighting, there more injury hazard when bulls are handled in a group.

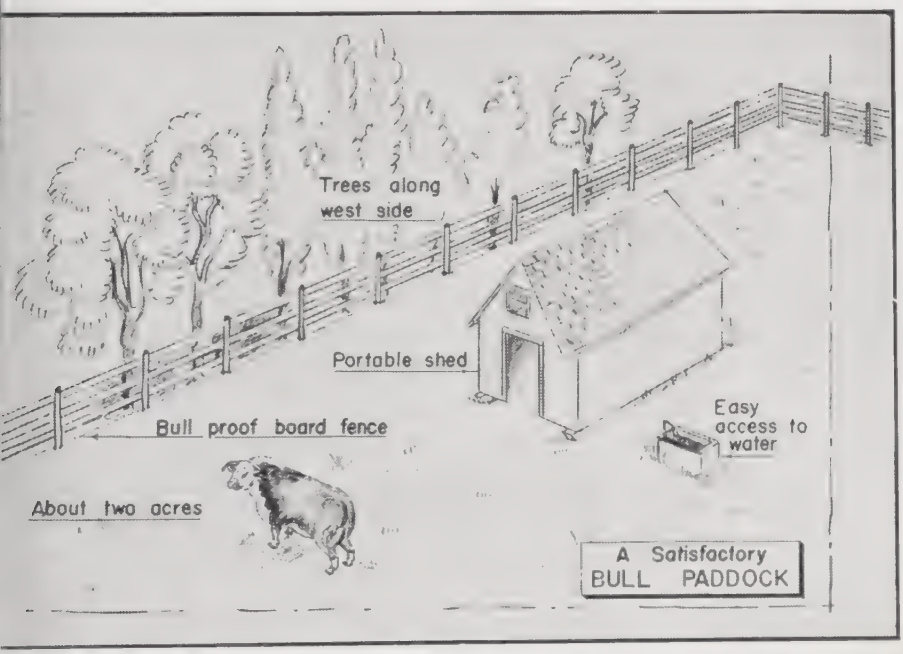


Fig. 159. This arrangement for the herd bull has proved most satis-ctory at The State College of Washington. Note the size of the pasture ddock, the individual portable shelter, and the water tank, shade, and ll-proof board fence. (Drawing by R. F. Johnson.)

Under range conditions, it is rather difficult to give the bulls uch attention during the breeding season. Usually the proper umber of bulls are simply turned with the cow herd. During the alance of the year, however, the bulls are usually kept separate. hus, if the producer desires calves that are dropped from Febru-ry 1 to June 1, the bulls are turned with the cows about May 1 nd are removed September 1.

The feeding of the herd bull is fully covered in Chapter XIV. brief, it may be said that the feeding program should be such s to keep the bull in a thrifty, vigorous condition at all times.

GE AND SERVICE OF THE BULL

The number and quality of calves that a bull sires in a given eason is more important than the total number of services. The

number of services allowed will vary with the age, development, temperament, health, breeding condition, distribution of services, and system of mating (pasture or hand mating). With pasture mating, size of area, carrying capacity of the range, and the size of the herd are important factors. Therefore, no definite best number of services can be recommended for any and all conditions, and yet the practices followed by good cattlemen do not differ greatly. For best results, a bull should be at least fifteen months old and well grown for his age before being put into service. Even then, it is best to follow a system of hand mating until the bull is two years of age.

With hand-mating, a senior yearling may breed ten to twelve cows per season, the two-year-old, twenty-five to thirty; whereas a bull three years old or over can be counted on for forty to fifty cows. With pasture mating, only a little more than half this number of cows can be bred. Though the type of range and the size of herd must be considered, the western rancher, on the average, figures his breeding needs on the basis of four bulls for each hundred cows.

A bull should remain a vigorous and reliable breeder up to ten years of age or older, provided that he has been managed properly throughout his lifetime. Should the bull prove to be an uncertain breeder, he should be given rest from service, forced to take plenty of exercise, and then placed in proper condition—neither fat nor thin. Sometimes a bull that is being "let-down" in condition following showing will be temporarily sterile during the reducing process. Even though this lack of fertility may last for a year, usually such animals "bounce back."

CARE OF THE PREGNANT COW

The nutritive requirements of the pregnant cow are less rigorous than those during lactation. In general, pregnant cows should be provided as nearly year-round pasture as possible. During times of inclement weather or when deep snows or droughts make supplemental feeding necessary, dry roughages and silage are the common feeds. If produced on fertile soils, such forage will usually provide all the needed nutrients for reproduction. Further discussion of the nutritive needs of pregnant cows is contained in Chapter XIV.

No shelter is necessary except during periods of inclement weather. Normally, the cows will prefer to run out-of-doors. This desire is to be encouraged—in order to provide exercise, fresh air, and sunshine. Where and when shelter is necessary, it should



Fig. 160. Breeding cows on pasture at Flat Top Ranch, Walnut Springs, xas. Pregnant cows should be provided as nearly year-round pasture as possible. (Courtesy, National Cottonseed Products Association, Inc.)

neither elaborate nor expensive. An open shed facing away om the direction of prevailing winds is quite as satisfactory for e protection of dry cows as a warm bank barn with individual x stalls—and it is far less expensive. The chief requirements e that the shelter be tight overhead, that it be sufficiently deep afford protection from inclement weather and remain dry epths of thirty-four to thirty-six feet are preferred), that it is ell drained, and that it is of sufficient size to allow the animals move about and lie down in comfort.

ARE OF THE COW AT CALVING TIME

As has been previously indicated, the period of gestation of cow is about 283 days, but it may vary a few days in either rection. The careful and observant caretaker, therefore, will be er alert and will make definite preparations in ample time. It especially important that first-calf heifers be watched at lving time, for frequently they will need some assistance. Older ws that habitually have trouble in parturition may well be lled from the herd.

gns of Approaching Parturition

Perhaps the first sign of approaching parturition is a dis-nded udder, which may be observed some weeks before calving me. Near the end of the gestation period, the content of the ud-

der changes from a watery secretion to a thick, milky colostrum. As parturition approaches, there generally will be a marked shrinkage or falling away of the muscular parts in the region of the tail head and pin bones, together with a noticeable enlargement and swelling of the vulva.

The immediate indications that the cow is about to calve are extreme nervousness and uneasiness, separation from the rest of the herd, and muscular exertion and distress.

Preparation For Calving

At the time the signs of approaching parturition seem to indicate that the calf may be expected within a short time, arrangements for the place of calving should be completed.



Fig. 161. A good start in life. When the weather is warm, the most natural and ideal place for calving is a clean, open pasture, away from other livestock. Under pasture conditions, there is less danger of either infection or mechanical injury to the cow and calf.

During the seasons of the year when the weather is warm, the most natural and ideal place for calving is a clean open pasture away from other livestock. Hogs should not be allowed in the same place with the cow, for they are likely to injure or kill the young calf. They have even been known to injure the cow.

Under pasture conditions, there is decidedly less danger of either infection or mechanical injury to the cow and calf. In commercial range operations, it is common practice to ride the range more frequently at calving time. A better procedure consists of having a smaller pasture adjoining headquarters into which heavy springing cows are placed a few days before calving. With the added convenience of such an arrangement, the animals can be given more careful attention.

During inclement weather, the cow should be placed in a my (10 or 12 feet square) well-lighted, well-ventilated, com- table box stall or maternity pen which should first be carefully aned, disinfected, and bedded for the occasion.

rmal Presentation

"Labor pains" in a mild form usually start some hours be- e actual parturition. After a time, the "water bag" appears the outside, usually increasing in size until it ruptures from weight of its own contents. This is closely followed by the pearance of the amniotic bladder (the second water bag), with fetus. With the rupture of the second "water bag," the aining becomes more violent, and presentation soon follows. st commonly in presentation, the front feet come first followed the nose which is resting on them, then the shoulders, the ddle, the hips, and then the hind legs and feet.

With posterior presentation (hind feet first), there is likely be difficulty in calving. Moreover, there is considerably more nger of having the calf suffocate through rupture of the um- cal cord and strangulation.

ndering Assistance

A good rule for the attendant is to be near but not in sight. presentation is normal and within an hour or two after the set of signs of calving, no assistance will be necessary. On the er hand, if the cow has labored for some time with little gress or is laboring rather infrequently, it is usually time to e assistance. Such aid will usually consist of fastening small es around the pasterns and pulling the young outward and vnward as the cow strains. This should be done by an experi- ed caretaker or a competent veterinarian. It is always well be reminded that rough, careless, or unsanitary methods at h a time may do more harm than good.

e Newborn Calf

If parturition has been normal, the cow can usually take e of the newborn calf, and it is best not to interfere. How- r, in unusual cases, it may be necessary to wipe the mucus m the nostrils to permit breathing; or more rarely yet, arti- al respiration methods must be applied to some calves. This y be done by blowing into the mouth, working the ribs, rub- g the body rather vigorously, and permitting the calf to fall tly. The cow should be permitted to lick the calf dry.

With calves born in sanitary quarters or out on clean pastures, there is little likelihood of navel infection. To lessen the danger of such infection, the navel cord of the newborn calf should be treated at once with a 10-per-cent solution of tincture of iodine.

A vigorous calf will attempt to rise in about fifteen minutes and usually will be nursing in half an hour to an hour. The weaker the calf, the longer the time before it will be able to be up and nursing. Sometimes it may even become necessary to assist the calf by holding it up to the cow's udder.

The colostrum (the milk yielded by the mother for a short period following the birth of the young) is most important for the well being of the newborn calf. Experiments have shown that it is almost impossible to raise a calf that has not received any colostrum. Aside from the difference in chemical composition, compared with later milk, the colostrum seems to have the following functions:

1. It contains antibodies which temporarily protect the calf against certain infections, especially those of the digestive tract.
2. It serves as a natural purgative, removing fecal matter which has accumulated in the digestive tract.
3. It contains a very high content of vitamin A, from ten to a hundred times that of ordinary milk. This provides the young calf, which is born with little body storage of this vitamin, with as much vitamin A on the first day as it would secure in some weeks from normal milk.

Usually it is best to keep the cow and calf in a small pasture for a few days. After this, they may be turned back with the main herd. Nothing is better for the cow at calving time than plenty of grass, and both the cow and calf will be helped by an abundance of fresh air and sunshine. The cow may deliberately hide the calf for the first few days, and the job may be so thoroughly done as to require considerable cleverness on the part of the caretaker to find it.

The Afterbirth

Under normal conditions, the fetal membranes (placenta or afterbirth) are expelled from three to six hours after parturition. Should they remain as long as twenty-four hours after calving, competent assistance should be given by an experienced caretaker or a licensed veterinarian. The operation of removing a retained afterbirth requires skill and experience; and if improperly done, the cow may be made a nonbreeder. Furthermore,

fore doing this, the fingernails should be trimmed closely; the nds and arms should be thoroughly washed with soap and rm water, disinfected, and then lubricated with vaseline or seed oil. In no case should a weight be tied to the placenta an attempt to force removal.

As soon as the afterbirth is ejected, it should be removed d burned or buried in lime as soon as possible, thus preventing e development of bacteria and foul odors. This step is less cessary on the open range, where animals traverse over a wide ea.

ORMAL BREEDING SEASON AND TIME OF CALVING

The season at which the cows are bred depends primarily the facilities at hand, taking into consideration the feed sup-, pasture, equipment, labor, and weather conditions; whether e cattle are being produced for ordinary commercial or for rebred purposes; and whether they are strictly beef or dual-rpose cattle.

The purebred breeder who exhibits cattle should plan the eeding program so that maximum advantage will be taken of e various age groups. In most livestock shows throughout the untry, the present classifications are based upon the dates of nuary 1, May 1, and September 1.

When it is intended to market milk from dual-purpose herds, e cows should be producing their largest flow of milk at a time nen the product is likely to bring the highest price. Usually is means fall calves, in order that milk may be sold throughout e fall and winter months.

In the commercial herd of beef cattle, two systems of breed-g are commonly practiced in regard to the season of the year. one system, the bulls are allowed to run with the cows roughout the year so that calving is on a year-round basis. is system results in greater use of the bull, and there is less lay in the first breeding of the heifers as soon as they are fficiently mature. On the other hand, often the calves arrive undesired and poorly adapted times; the breeding system without order and regularity; and the calves usually lack iformity. This system is frequently followed in the central d southern states.

The other system of breeding followed with the commercial rd, and the most widely used system on the western range, that of having all of the breeding done within a restricted ason (of about three months) so that the calves arrive within

a short spread of time—usually in the spring. Sometimes in the central and southern states this system is used. Having the calves born about the same time, whether it be fall or spring, results in greater uniformity. Thus it is easier to care for (brand, dehorn, castrate, vaccinate, etc.) and market such animals. Each farm has its individual problems, and the decision must be made accordingly.

Advantages of Spring Calves

The production of spring calves has the following advantages:

1. In producing spring calves, the cows are bred during the most natural breeding season—at a time when they are on pasture, gaining in flesh, and more likely to conceive. The calving percentage is usually higher, therefore, with a system of spring calving.

2. The calves will be in shape to sell directly from the cows in the fall, at which time there is a good demand for feeder calves.

3. If the calves are to be sold as yearlings, one wintering is saved; or if they are to be sold at weaning time, no wintering is required.

4. Because of greater utilization of cheap roughage, dry cows may be wintered more cheaply.

5. Less labor and attention is required in caring for the calves the first winter.

6. Spring calves require less grain and utilize the maximum amount of pasture and roughage.

Advantages of Fall Calves

The production of fall calves has the following advantages:

1. The cows are in better condition at calving time.

2. The cows give more milk for a longer period.

3. The calves make better use of the grass during their first summer.

4. The calves escape flies, screw worms, and heat while they are small. (This is especially important in the South).

5. Upon being weaned the following spring, the calves can be placed directly on pasture instead of in a dry lot; or, if it is desired to sell, they usually find a ready market ahead of the influx of fall feeder calves from the range area.

6. When it is intended to sell market milk from dual-purpose
s, fall calves are usually best. The greater flow of milk is
ained during the period of highest prices.

NORMAL DEVELOPMENT OF SEX IN CATTLE

A peculiar form of sterility usually occurs in heifers born
n to a bull. Such sterile heifers are called "freemartins." This
dition prevails in about nine out of ten twin births when a
f of each sex is involved. The fetal circulations fuse, and the



Fig. 162. Grade Guernsey female (mounted) showing Achondroplasia bulldog condition. Assumed to be the result of homozygous recessive es. Lethals of this type have been reported as occurring in the Tele-rk, Holstein, and Guernsey breeds. (Courtesy, Graydon W. Brandt, e Clemson Agricultural College, South Carolina.)

ale hormones get into the circulation of the unborn female
ere they interfere with the normal development of sex and
odify the female embryo in the direction of the male. In about
per cent of heifers born twin to a bull, fusion of the circula-
n does not occur, and the animal is normal and fertile. As, on
e average, only one out of each ten heifers born twin to a bull
e normal, it is usually considered best to sell such animals for
ughter, unless very valuable purebred cattle are involved.

In addition to "freemartins," occasionally other abnormal
xual developments occur in animals, namely, hermaphrodites
d intersexes. Hermaphrodites are animals that possess charac-

teristics of both sexes; whereas intersexes do not possess definite characteristics of either sex. These conditions occur sporadically when something happens to the embryo to disturb normal development.

LETHALS AND OTHER HEREDITARY ABNORMALITIES

The list of lethals and nonlethals in cattle, Table 25, shows the great variety of defects that may be hereditary. It includes most of the well authenticated conditions that have been reported.

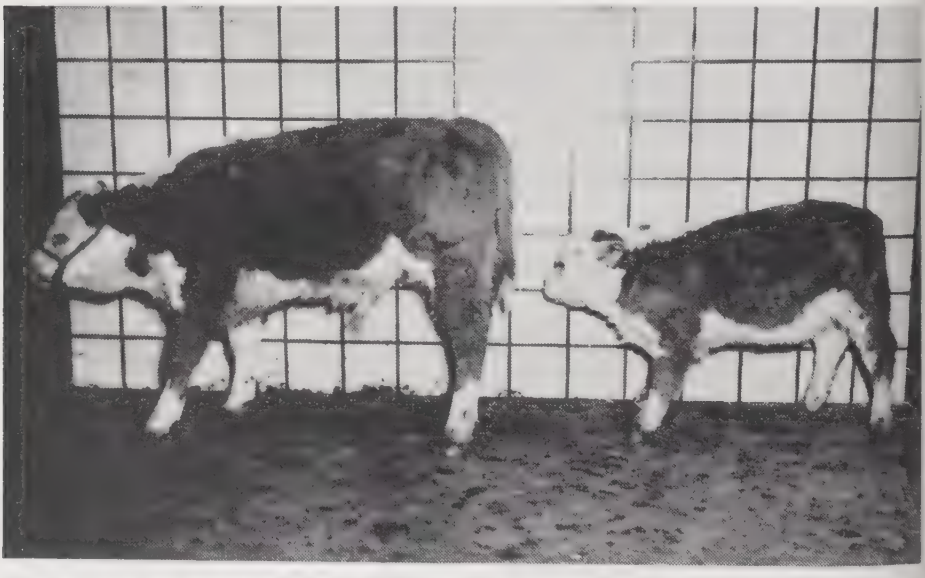


Fig. 163. Normal (left) and "dwarf" (right) Hereford calves. The normal calf is $2\frac{1}{2}$ months of age while the dwarf is $3\frac{1}{2}$ months of age. Note the smaller size of the dwarf and its stocky well-built conformation. (Courtesy, The State College of Washington.)

In recent years, a disturbing condition known as "dwarfs" (or "midgets") has appeared in increasing frequency among beef cattle, probably in all breeds. Though very small (usually weighing about half as much as normal calves), these calves are exceedingly stocky and well built. The heads are beautifully shaped and the eyes protrude, giving a characteristic "pop-eyed" appearance. Some dwarfs are weak and unsteady in gait at birth. Others appear to be strong enough, but soon develop a large stomach, heavy shoulders, crooked hind legs and sometimes labored breathing. Survival is somewhat lower than with normal calves, though most purebred breeders make no attempt to raise them.

On the basis of published and unpublished data, there is w almost complete agreement among scientists (1) that the arf condition is of genetic origin, and (2) that it is inherited a simple antosomal recessive (the word "antosomal" meaning at the factor is not carried on the sex chromosome).

Because of the increasing frequency of dwarfs and the fact at they represent an almost complete economic loss, the prob- n deserves careful attention. An analysis of dwarf-afflicted rds and suggested methods of purging them of dwarfs is given Chapter VI of **Beef Cattle Husbandry**, a book by the same thor and the same publisher as **Animal Science.**



Fig. 164. A grade "1" bull. The bull-grading movement has been a werful influence in improving the quality of the cattle on the ranges of e West. (Courtesy, Joe Muir, Extension Animal Husbandman, The State llege of Washington.)

ULL GRADING

In recent years, bull-grading programs have had a tremen- ous effect on improving the commercial cattle on the western nges of this country. Perhaps this movement received its reatest impetus in those areas where several owners run herds n unfenced public grazing lands. Formerly, those progressive anchers who believed that only purebred beef bulls of high uality should be used could do nothing to prevent the presence f inferior bulls on these public ranges. The man who bought

TABLE 25

SOME HEREDITARY LETHALS AND OTHER HEREDITARY ABNORMALITIES THAT HAVE BEEN REPORTED WITH CATTLE

Type of abnormality	Description of abnormality	Probable mode of inheritance
A. *Lethals:*		
Achondroplasia I or bull-dog calves	Short legs and head; often have hernia and cleft palate. Delivery when close to term is usually difficult because of the extremely large head. About one-fourth of the Dexter X Dexter matings are "bull-dogs."	Dominant
Achondroplasia II or bull-dog calves	This type is similar to Achondroplasia I, but less extreme. Calves are usually carried to term. It has been reported as occurring in the Telemark, Holstein, and Guernsey breeds.	Recessive
Acroteriasis congenita or amputated	Appendages short or absent. The calves are stillborn or die shortly after birth. It has been reported in Swedish Holsteins.	Recessive
Agnathia	Very short lower jaw. Sex limited to male.	Recessive
Ankylosis	Ossification of joints. It has been reported in Norwegian Lyngdal cattle.	Recessive
Congenital dropsy	Water in tissues and cavities. The calves are born one or two months previous to term or at term. It has been reported in black and white Swedish Lowland cattle.	Recessive
Congenital ichthyosis	Scaly, cracked skin.	Recessive
Epitheliogenesis imperfecta	Imperfect skin, partly hairless; septicemia. The calves are usually born at term but die as a result of bacterial invasion. Calves of this type have been found in the Holstein, Jersey, and Shorthorn breeds.	Recessive
Fetal resorption	Various stages from decomposed masses to only bones or dried mummies have been reported.	?
Hernia cerebri	Failure of frontal bones to fuse.	?

Hypotrichosis congenita	A hairless condition reported in Swedish Holsteins. A little hair is found on the muzzle, eyelids, ears, pasterns, and end of the tail. The calves die shortly after birth.	Recessive
Impacted molars	Short jaw, impacted teeth; die within week. The condition has been found in Milking Shorthorns.	?
Lameness in hind limbs	Calves unable to stand.	Recessive
Muscle contracture	Head and legs drawn; joints stiff. Usually die as eight-month fetus.	Recessive
Short limbs	Limbs short; hoofs undeveloped.	Recessive
Short spine	Ribs and vertebrae fused; back bent down.	Recessive
B. *Non-lethals:*		
Cataract	Opaque condition of the lens of the eye.	Recessive
Duck leggedness	Legs shorter than normal.	Semi-dominant
Dwarfism (or midgets)	Animals small in size but well proportioned.	Recessive
Epilepsy	Cattle subject to epileptic type of attacks.	Semi-dominant
Female sterility	Cows fail to settle.	Recessive
Flexed pasterns	Toes turned under.	Recessive
Notched ears	Ears imperfect in shape.	Dominant
Screw tail	One or more vertebrae fused.	Recessive
Semi-hairlessness	Hair coat thin; calves wild.	Recessive
Strabismus	Cattle have a cross-eyed condition.	Recessive
Wry tail	Base of tail set at angle to backbone.	Recessive

superior bulls got no more use from them than his neighbor who turned out scrubs because he could buy them cheaply. But this problem was solved when groups of cattlemen using common ranges decided to have their bulls classified and to use only bulls of certain standards. Perhaps this movement has had its greatest following in the state of Utah, where it is estimated that 90 per cent of all range bulls have been graded.

In most bull-grading programs, the grades are designated numerically as 1, 2, 3, and 4. The "1" bulls are top animals in most every respect—the kind that are good enough to head purebred herds. The "2" bulls may be a little deficient here or there, but they are considered good enough to sire choice feeder calves. The "3" bulls are occasionally used, but because of their deficiencies, no self-respecting rancher wishes to display them. The "4" bulls are the kind that everyone wishes to castrate quickly.

In some areas of the West, all animals consigned to range bull sales are now graded, with the requirement that they must grade "2" or higher in order to be sold. Sometimes grazing permits are refused or delayed because of ranchers refusing to use graded bulls.

The bull-grading movement has been a powerful influence in improving the quality of the cattle on the ranges of the West. The program is firmly entrenched. In the future, it is predicted that production testing will become an added and useful adjunct to bull grading.

PRODUCTION TESTING BEEF CATTLE

In comparison with that of chickens or even swine, production testing of beef cattle is slow, and, like most investigational work with large animals, it is likely to be expensive. Even so, in realization that such testing is absolutely necessary if maximum improvement is to be made, the progressive purebred beef cattle breeder will wish to make a start. The following items appear to be of greatest importance in evaluating the profitability of beef cattle.

1. **Regular production on the part of the cows.**—Although a 100-per-cent calf crop is desired, under practical conditions this is seldom achieved. Certainly any barrenness that may be hereditary had best be dealt with by removing the animals from the herd.

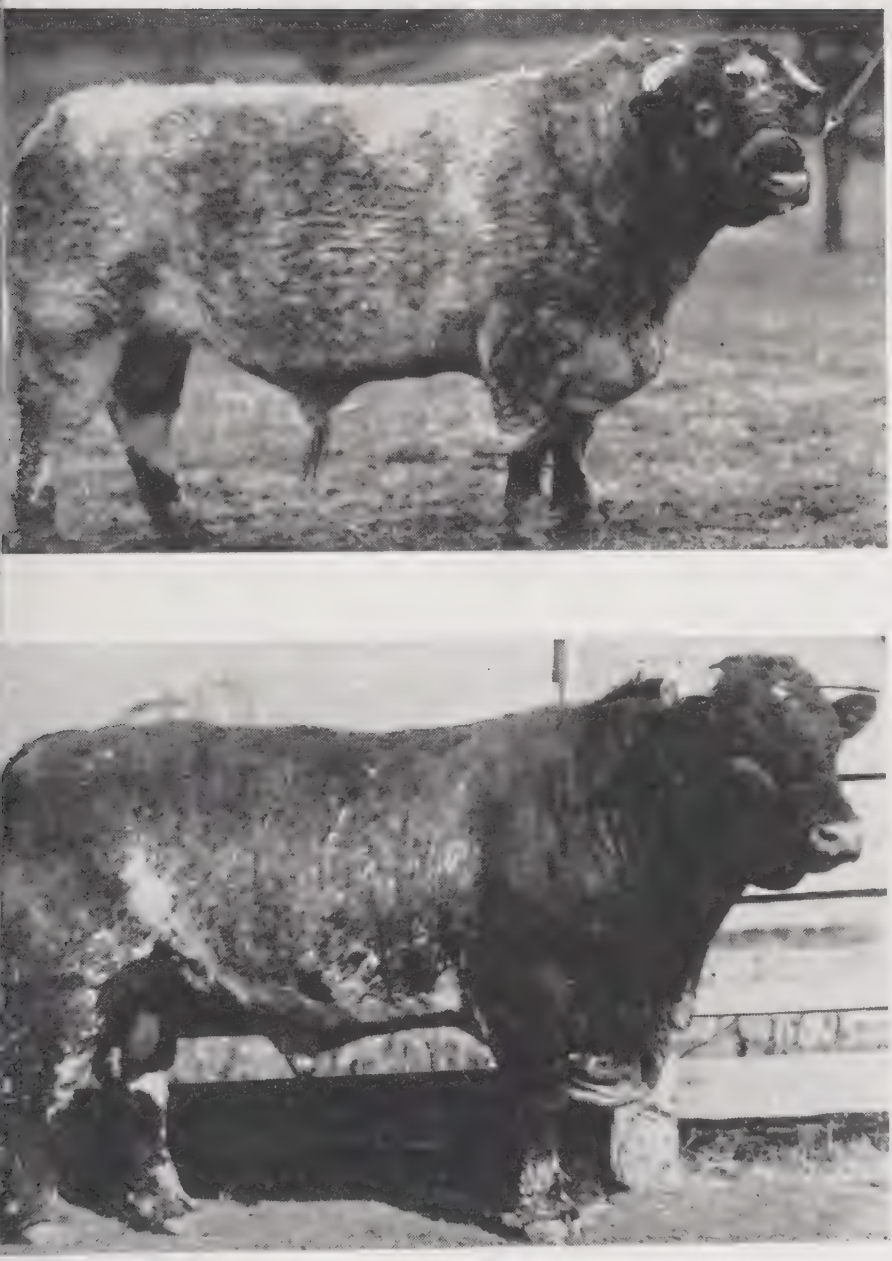


Fig. 165. Progeny tests of these two Shorthorn bulls showed that their earance was not a reliable indicator of breeding ability. These animals full brothers, but most cattlemen would agree that the top bull is the re attractive in appearance. However, the bull in the lower picture pro- ed calves that were 42 pounds heavier at the end of a feeding period and t slaughtered out higher-grading carcasses. The average return per calf s nearly $5.00 greater than from those sired by the top bull. (Courtesy, .D.A., Bureau of Animal Industry.)

2. **Birth weight of calves.**—The larger, more vigorous calves at birth seem to retain these advantages to maturity.

3. **Weaning weight of calves.**—The weaning weight is an indication of the milking ability of the cow, but it must be realized that pasture and feed conditions are also a major factor.

4. **Rate of gain from weaning to market weight.**—Daily rate of gain is important for the reason that it is highly correlated with efficiency of gain.

5. **Efficiency of feed utilization.**—Where convenient, it is well that accurate feed records be kept to arrive at the number of pounds of feed required per hundredweight pounds of gain. This factor is best measured by feeding the animals from weaning age (six to seven months of age) to twelve months or more of age. Self-feeding minimizes the human factor.

6. **Body type.**—It must always be remembered that the ultimate objective in beef production is the sale of meat over the block. The body type of the animal should be based on the demands and prices of a *discriminating market as projected into the future.*

Certainly, from the ultimate experimental standpoint, the fifth point listed above would require that individual feed records be kept on each animal in the herd—a procedure which is obviously impractical under most conditions. Instead, the practical cattleman may keep group feed records—through feeding together young animals of similar ages—or, if necessary, disregard this criterion and concentrate on the other five points. In any event, individual feed records on prospective herd sires are extremely important.

But efficiency of feed utilization should not be the sole criterion. After all, certain Holsteins, for example, may produce beef more efficiently than many members of the established beef breeds, but the dairy-type animal does not add sufficient carcass weight in the regions of the high-priced cuts.

A prerequisite for any production data is that each animal be positively identified—by means of ear notches, ear tags, or tattoos. For purebred breeders, who must use a system of animal identification anyway, this does not constitute an additional detail. But the taking of weights and grades does require additional time and labor—an expenditure which is highly worth while, however.

Body-type scores had best be taken at a standard age, probably being evaluated in terms of either a numerical score or a

Sex:

Owner and Address

Date of Birth

Herd No. or Call	Date of Birth	Weaning Data								____ Data					Dam Data					Remarks
		Weaning Date	Weaning Age in Days	Weight in Lbs.	Daily Gain from Birth Weight	Adj. ___ Day Weaning Weight	Rating on Weights and Gain	Grade	Grade Percentage	Date Weighed	Weight	Wt. Adj. to ___ Mo	Grade	Grade Percentage	Herd No.	Age This Year	Mature Weight	Grade	Grade Percentage	
Totals																				
Aver.																				

Fig. 166. Get of Sire Record. This form is now in use with cooperating beef cattle breeders in Washington, with the W.S.C. Department of Animal Husbandry and Agricultural Extension Service supervising the studies.

INDIVIDUAL LIFE RECORD OF DAM

Owner
Breeder
Address

Name Reg. No.
Herd No.
Date of Birth

Sire
Grade Wt.
Breeder No.

Dam
Grade Wt.
Breeder No.

Grade Wt. / Breeder No.
Grade Wt. / Breeder No.
Grade Wt. / Breeder No.
Grade Wt. / Breeder No.

Grade Wt. / Grade Wt.
Grade Wt. / Grade Wt.
Grade Wt. / Grade Wt.
Grade Wt. / Grade Wt.

INDIVIDUAL WEIGHT AND GRADE RECORD OF DAM

Date	Age	Weight	Condition	Grade

REMARKS:

DISPOSAL:

PRODUCE RECORD

Herd No. of Calf	Sex of Calf	Date of Birth	Name of Calf	Reg. No. of Calf	Name of Sire	Weaning Data: Date	Weight	Wt. Adj. to ___ Mo.	Rating on Wts. and Gains	Grade	Data: Date	Weight	Wt. Adj. to ___ Mo.	Grade	Remarks
Totals and Averages															

Fig. 167. Individual Life Record of Dam. This form is now in use with cooperating beef cattle breeders in Washing-
[illegible] Department of Animal Husbandry and Agricultural Extension Service [illegible] the studies

ter. It is important that all animals be evaluated and their ores made a part of the permanent record. Consistently good oduction is to be desired. It should be realized that it is all too sy for a breeder to remember the good individuals produced by iven cow and to forget those which are mediocre or culls.

In order not to be burdensome, the record forms should be atively simple. Furthermore, they should be in a form that l permit easy summarization—for example, the record of one v should be on one sheet if possible. Suggested record forms v in use by cattle breeders cooperating with The State College Washington are shown in Figures 166 and 167.

Information on the productivity of *close relatives* (the sire d the dam and the brothers and sisters) can supplement that the animal itself and thus be a distinct aid in selection. The oduction records of more distant relatives are of little signifi- nce, because individually, due to the sampling nature of inher- nce, they contribute only a few genes to an animal many nerations removed.

Under practical conditions, progeny testing of cattle is ually confined to the bull, as a male produces during his etime many more offspring than a female. Because of the atively small numbers of offspring, progeny testing with fe- les (except with litter-bearing sows) is somewhat more diffi- t; and as a rule, a female cannot be thoroughly progeny ted until she has spent half or more of her lifetime in a herd. rtainly, the intelligent breeder should study his females and l those which consistently fail to produce good offspring. If ssible, the females should also be progeny tested—especially ose that may become the dams of herd bulls.

A good plan in properly testing bulls consists of retaining and ting one or more young bulls—the numbers depending upon the e of the herd—on a limited number of females during their st season of breeding. The progeny are then tested and eval- ted, and only those bulls that prove to be best on the basis of eir progeny are retained for further breeding purposes. If ung bulls eighteen months of age are each mated to eight to elve females, calves should be born nine months later, and e progeny can be tested between the ages of seven and twelve nths. Thus, with good fortune, it is possible to have progeny ta on a beef bull when he is approximately thirty-nine months age. With dairy bulls, whose daughters must be in lactation in der to make the test, it is not possible to make an evaluation til the animal is six to seven years of age.



Fig. 168. Hereford steers grazing on a western range, with hay stacked for winter feeding. Pastures and other roughages are the very foundation of successful beef cattle production. (Courtesy, U. S. Forest Service.)

CHAPTER XIV

FEEDING BEEF CATTLE[1]

Pastures and other roughages, preferably with a maximum of the former, are the very foundation of successful beef cattle production, for it is estimated that 80 per cent of the total feed of beef cattle is derived from roughages. If produced on well-fertilized soils, green grass and well-cured, green, leafy hay can supply all of the nutrient requirements of beef cattle, except the need for common salt and whatever energy-rich feeds may be necessary for additional conditioning or dry-lot fattening.

High-percentage calf crops, heavy weaning weights, continuous and rapid growth of young stock, and optimum utilization of feed-lot rations in the fattening process are important; and all are based largely upon adequate nutrition. Improvements in each of these categories is well within the realm of realization on a practical basis.

SPECIFIC NUTRITIVE NEEDS OF BEEF CATTLE

As feeds represent by far the greatest cost item in beef production, it is important that there be a basic understanding

[1]Although Webster defines the noun **ration** as "the amount of food supplied to an animal for a definite period, usually for a day," to most stockmen the word implies the feeds fed to an animal or animals, without limitation to the time in which they are consumed. In this and other chapters of **Animal Science**, the author accedes to the common usage of the word rather than to dictionary correctness.

the nutritive requirements. For convenience, these will be scussed under the following groups: (1) protein needs, (2) ergy needs, (3) mineral needs, (4) vitamin needs, and (5) ater needs.

otein Needs

The protein requirements of beef cattle have become more itical with the shift in beef production practices during the st two decades. Steers were formerly permitted to make their owth primarily on roughages—pastures in the summertime d hay and other forages in the winter. After making moderate d unforced growth for two to four years, usually the animals ere either turned in the feed lot or placed on more lush pastures r a reasonable degree of finishing. With this system, the growth d fattening requirements of cattle came largely at two separate riods in the life of the animal.

Under the old system of moderate growth rate, reasonably od pastures and good quality hay fully met the protein require- ents as well as the mineral and vitamin needs. As the feeding riod was not so long with these older cattle, in comparison with e period required in the fattening of calves or yearlings, there so was less tendency for vitamin deficiencies to show up in the ed lot; and the protein requirements were less important during e finishing period.

In recent years, there has been considerable change in beef oduction practices. The preference of the consumer for smaller ts of beef—meats that are more tender and have less fat—ade for a shift in management and marketing. Today, increas- g numbers of cattle are fattened at early ages and marketed baby beef. Such animals are in forced production. Their bodies e simultaneously laying on fat and growing rapidly in protein ssues and skeleton. Their nutritive requirements are more crit- al, therefore, than those of older cattle, especially from the andpoint of proteins, minerals, and vitamins.

The protein allowance of beef cattle, regardless of age or stem of production, should be ample to replace the daily break- wn of the tissues of the body as well as to provide for the owth of hair, horns, hoofs, and tissue. In general, the protein eds are greatest for the growth of the young calf and for the stating-lactating cow.

As protein supplements ordinarily cost more per ton than ains, beef cattle should not be fed larger quantities of these pplements than actually needed. On the other hand, it may

be economical in certain areas to provide more protein supplements than are required. The latter situation often applies in the feeding of alfalfa hay in the West and cottonseed meal in the South.

With yearlings or older cattle that are being fattened, or in the maintenance of the beef-breeding herd, it usually does not pay to add a protein supplement when a legume hay is fed. With younger cattle, or when the breeding herd is being wintered on a non-legume roughage, sufficient protein supplement—usually one to two pounds daily—should be added to the ration. Cottonseed oil meal or cake, linseed oil meal or cake, and soybean oil meal or cake are the most economical protein supplements for beef cattle.

Because of rumen synthesis of essential amino acids by microorganisms, the quality of proteins is of less importance in the feeding of beef cattle than in feeding some other classes of stock. Proteins from plant sources, therefore, are quite satisfactory.

Energy Needs

A relatively large portion of the feeds consumed by beef cattle are used in meeting the energy needs, regardless of whether the animals are merely being maintained (as in wintering) or fed for growth, fattening, or reproduction.

The first and most important function of feeds is that of meeting the maintenance needs. If there is not sufficient feed, as is frequently true during periods of droughts or when the winter rations are skimpy, the energy needs of the body are met by breaking down of tissue. This results in loss in condition and body weight.

After the energy needs for maintenance have been met, any surplus energy may be used for growth or fattening. With the present practice of fattening cattle at early ages, growth and fattening are in most instances simultaneous and therefore not easily separated.

In the fattening process, the percentage of protein, ash, and water steadily decreases as the animal matures and fattens, whereas the percentage of fat increases. Thus the body of a calf at birth may contain about 70 per cent water and 4 per cent fat, whereas the body of a fat two-year-old steer may contain only 45 to 50 per cent water but from 30 to 35 per cent fat. This storage of fat requires a liberal allowance of energy feeds.

Through bacterial action in the rumen, cattle are able to

ilize a considerable proportion of roughages as sources of ener-
. Yet it must be realized that with extremely bulky rations the
imal may not be able to consume sufficient quantities to pro-
ce the maximum amount of fat. For this reason, fattening
tions contain a considerable proportion of concentrated feeds,
ostly cereal grains. On the other hand, when the energy re-
irements are primarily for maintenance, roughages (pastures
d dry forages) are usually the most economical sources of
ergy for beef cattle.

ineral Needs

It is generally agreed that the mineral requirements of beef
ttle are less critical than those of most other classes of live-
ock. On the other hand, cattle are subject to the usual ineffi-
ency and ailments when subjected to prolonged and severe
neral deficiencies.

A sound recommendation for all classes and ages of cattle
to provide free access to a mineral box containing two com-
rtments, one of which contains salt (stabilized iodized salt in
line-deficient areas) and the other, steamed bone meal (or
eferably a mixture of 1 3 salt and 2 3 steamed bone meal).
e salt will always be needed; and the bone meal will be cheap
surance, with the animal eating it if either calcium or phos-
orus, or both, are lacking in the ration.

ALCIUM:

In contrast with phosphorus deficiency, calcium deficiency in
ef cattle is relatively rare and mild and the symptoms much
ss conspicuous. In general, when a legume forage is available
egume hay, pasture, or silage), ample calcium will be provided.
t even non-legume forages contain more calcium than cereal
ains. This indicates that a mineral source of calcium is less
cessary when large quantities of roughage are being consumed.
so, plants grown on calcium-rich soils contain a higher content
this element.

As fattening steers consume a high proportion of grains to
ughages—and the grains are low in calcium—they will have
greater need for a calcium supplement than will beef cattle
at are being fed largely on roughages. This is especially true
cattle of the younger ages and where a long feeding period
involved.

When the ration of beef cattle is suspected of being low in
lcium, the animals should be given free access to a calcium
pplement, with salt provided separately—or 0.1 pound of a

calcium supplement (ground limestone or feeding steamed bone meal) may be added to the daily ration.

PHOSPHORUS:

In many sections of this and other countries, the soils are so deficient in phosphorus that the feeds produced thereon do not provide enough of this mineral for cattle or other classes of stock. As a result, the cattle produced in these areas may have depraved appetites, may fail to breed regularly, and may produce markedly less milk. Growth and development are slow, and the animals become emaciated and fail to reach normal adult size. Death losses are abnormally high.

In range areas where the soils are either known or suspected to be deficient in phosphorus, cattle should always be given free access to bone meal. The need for a phosphorus supplement in such areas is strikingly illustrated by the following observations made on the King Ranch in Texas:

> "Analysis of records for two calving seasons showed that 85 per cent of the cows receiving phosphorus supplement produced calves, as compared with 64 per cent for the other cows. Calves from the phosphorus supplement-fed cows averaged 69 pounds more at weaning, and 126 pounds more at 18 months of age than the others. After deduction of the cost of the supplement, the value of the weaned calves averaged $5.78 more. In further tests, phosphorus was supplied (1) in the form of bone meal placed in self-feeders, (2) by dissolving disodium phosphate in the drinking water, and (3) by applying a super-phosphate fertilizer to the pasture. All methods were satisfactory, the last giving the best results."[1]

Fattening cattle that are receiving one pound or more per head daily of a protein supplement of plant origin (one pound per head per day of cottonseed meal, soybean meal, linseed meal, etc., or two pounds per head per day of cull peas—supplements high in phosphorus), will receive an ample supply of this mineral. On the other hand, when the fattening ration consists of a high proportion of beet by-products (wet or dried beet pulp or beet molasses) or other feeds very low in phosphorus, there may be a marked advantage in adding bone meal or some other phosphorus supplement. This is especially true when young cattle are on a long feed. Under such conditions, the cattle should either have free access to bone meal or one-tenth pound per head daily should be added to the ration.

[1]Research Achievement Sheet, U. S. Dept. of Agri. This work was done in cooperation with the Texas Agri. Exp. Sta. and the Bureau of Animal Industry.

In order to be on the safe side, the general recommendation or beef cattle on both the range and in the fattening lot is to low free choice of bone meal and salt in separate compartments f a mineral box. This will give, at a low cost, the necessary rotection from the standpoint of both calcium and phosphorus.

ALT:

In iodine-deficient areas, stabilized iodized salt should always e used. Otherwise, dead or nonviable goiterous calves may be orn. Common salt is satisfactory in all other areas. In any event, lt should be available at all times.

Salt may be fed in the form of loose salt, rock salt, or block lt; but because of weathering losses, flake salt is not satisfac- ry for feeding in the open. If block salt is used, the softer types hould be selected.

Cattle on pasture consume more salt than those in the dry- t, and they have a higher requirement in the spring and early ummer when the forage is more lush than later in the season. attening cattle in the dry lot and under shelter will consume bout two-thirds of a pound of salt per head per month; whereas, ecause of weathering and greater wastage, about twice this mount must be provided when salt is exposed to the elements.

Most ranches compute the yearly salt requirements on the asis of about twenty pounds for each cow. Mature animals will onsume two to two and one-half pounds of salt per month when astures are lush and succulent and one to one and one-half ounds per month during the balance of the season.

Salt deficiency in cattle is manifested by intense craving for is mineral, lack of appetite, and unthrifty appearance. Heavily roducing milk cows may even collapse and die when the salt eficiency has been of long duration.

The careful location of the salt supply is recognized as an mportant adjunct in proper range management. Through judi- ious scattering of the salt supply and the moving of it at proper ntervals, the animals can be distributed more properly; and vergrazing of certain areas can be minimized. Likewise, some udgment should prevail in selecting the location of the mineral ox in the dry lot. For example, it should not be too near the atering trough; otherwise the animals will "slobber" water ver the minerals.

OBALT:

Cobalt deficiencies in cattle are costly, for the affected nimals become weak and emaciated and eventually die. Florida

is without doubt the most serious cobalt-deficient area in the United States, but similar deficiencies of a lesser order have been observed in Michigan, Wisconsin, New Hampshire, North Carolina, and New York. Cattle in these affected areas should have access to a cobaltized mineral mixture, made by mixing ½ ounce of a soluble cobalt salt per 100 pounds of either (1) salt, (2) bone meal, or (3) a mixture of ⅓ salt and ⅔ bone meal.

In different sections of the world, a cobalt deficiency is known as Denmark disease, coastal disease, enroötic marasmus, bush sickness, salt sickness, nakuritis, and pining disease.

Vitamin Needs

Under normal conditions, vitamin A is the only vitamin likely to be lacking. In usual production methods, beef cattle are exposed to enough direct sunlight to acquire their vitamin D needs, for the ultra-violet light in the sunlight penetrates the skin and produces vitamin D from traces of cholesterol in the tissues. Through rumen synthesis, it is most likely that all necessary quantities of the B vitamins and vitamin K are manufactured within the digestive tract, and adequate quantities of vitamin E are widely distributed in most all natural feeds. If vitamin C is required by cattle, it appears to be synthesized in ample quantities in the body. Thus only the supply of vitamin A is likely to be of concern to the practical beef cattle farmer or rancher.

Beef cattle will receive plenty of vitamin A when they are on green pastures or when they are fed a reasonable amount of bright green hay or silage, feeds which are high in carotene (pro vitamin A). Yellow corn and green peas are also good sources of vitamin A for cattle that are being grain fed.

Where vitamin A deficiencies in cattle have been reported on farms or ranches, usually one or more of the following conditions have prevailed:

1. An extended drought resulting in dry, bleached pastures.
2. Winter feeding on bleached hays (especially overripe cereal hays or straws) with little or no green hay or silage.
3. Feeding of fattening rations consisting of little or no green forage and no yellow corn, especially when the feeding in the dry lot for more than two to three months.

Water Needs

Water is cheap but essential. Beef cattle should have an abundant supply of it before them at all times. Mature cattle will

nsume an average of about twelve gallons of water per head ily, with younger animals requiring proportionally less. In the rthern latitudes, heaters should be provided to make the water ailable, but they are not needed to warm the water further.



Fig. 169. Yearling steers near water on a New Mexico ranch. Water is eap but essential. (Courtesy, C. B. & Q. Railroad Co.)

EEDS FOR BEEF CATTLE

The principal function of beef cattle is to harvest vast acreges of forages—including both pastures and dry roughages—nd, with or without supplementation, to convert these feeds into ore nutritious and palatable products for human consumption.

Beef cattle feeding practices vary according to the relative vailability of grasses and grains. Where grasses are abundant nd grain is limited, as in the western range states, cattle are rimarily grown out or fattened on roughages. On the other and, where grain is abundant, as in the Corn Belt states, fattenng with concentrates is common.

astures For Beef Cattle

Good pasture is the cornerstone of successful beef cattle prouction. In fact, there has never been a great beef cattle country r area which did not produce good grass. It has also been said nat a good farmer or rancher can be recognized by the character f his pastures and that good cattle graze good pastures. Thus the nree go hand in hand—good farmers, good pastures, and good attle. The relationship and importance of cattle and pastures as been further extolled in an old Flemish proverb which says, No grass, no cattle; no cattle, no manure; no manure, no crops."



Fig. 170. Hereford cattle on pasture, owned by S. H. Pharr, Cecil, Alabama. In the deep South, year-long grazing is approached. (Courtesy, National Cottonseed Products Association, Inc.)

Approximately 55.2 per cent of the total land area of the United States is devoted to pasture and grazing lands. Much of this area, especially in the far West, can be utilized only by beef cattle or sheep. Although the term "pasture" usually suggests growing plants, it is correct to speak of pasturing stalk and stubble fields. In fact, in the broad sense, pastures include all crops that are harvested directly by animals.

The type of pasture, as well as its carrying capacity and seasonable use, varies according to topography, soil, and climate. There is hardly any limit to the number of plants that are utilized as beef cattle pastures throughout the United States. In general, regardless of species or mixtures, pastures may be classified as permanent, cultivated, or supplemental. As the name indicates, permanent pastures are those which, with proper care, last for many years. They are most commonly found on land that cannot be profitably used for cultivated crops, mainly because of topography, moisture, or fertility. Cultivated pastures are of diverse character but include all crops used as pastures for a short period. Among the latter are such crops as sudan or lespedeza, which are seeded for the purpose of providing supplemental grazing during the season when the regular permanent or temporary pasture is relatively unproductive. Because of the hundreds of species of grasses and legumes that are used as beef cattle pastures, each with its own best adaptation, no attempt is made to discuss the respective virtues of each variety. Instead, it is recommended that the farmer or rancher seek the advice of

s local county agricultural agent or FFA instructor or write to s state agricultural college.

No method of harvesting has yet been devised that is as eap as that which can be accomplished through grazing by imals. Accordingly, successful beef cattle management necessi- tes as nearly year-round grazing as possible. In the northern titudes of the United States, the grazing season is usually of out six months' duration, whereas in the deep South year-long razing is approached. In many range areas of the West, the reeding herds get practically all their feed the year round from e range forage, being given supplemental feed only if the rass or browse is buried deep in snow.

In some instances, cattle on pasture fail to make the proper rowth or gain in condition because the soil is seriously deficient fertility or the pasture has not been well managed. In such stances, striking improvement will result from proper fertiliza- on and management.

ays and Other Dry Roughages for Beef Cattle

The dry roughages are all high in fiber and therefore low total digestible nutrients. Hay averages about 28 per cent ber and straw approximately 38 per cent, whereas such concen- rates as corn and wheat contain only 2 to 3 per cent fiber. For- nately, cattle are equipped to handle large quantities of rough- ges. In the first place, the paunch of a mature cow has a capacity f three to five bushels, thus providing ample storage for large uantities of less concentrated feeds. Secondly, the millions of icroorganisms in the rumen attack the cellulose and pentosans f the fibrous roughages, such as hay, breaking them down into vailable and useful nutrients. In addition to providing nutrients t low cost, the roughages add needed bulk to cattle rations.

Roughages, like concentrates, may be classified as carbona- eous or nitrogenous, depending on their protein content. The rincipal dry carbonaceous roughages used by cattle include hay rom the grasses, the straws and hays from cereal grains, and he stalks and leaves of corn and the grain sorghums. Cured itrogenous roughages include the various legume hays such s alfalfa, the clover hays, peanut hay, soybean hay, cowpea ay, and velvet bean hay.

Although leguminous roughages are preferable, it must be emembered that weather conditions and soils often make it ore practical to produce the non-legumes. Under such circum- tances, the feeding value of the non-legumes can be enhanced by

cutting them at an early stage of maturity and curing so as to retain as much of the carotene content as possible.

In comparison with good quality legume hays, the carbonaceous roughages are lower in protein content and in quality of proteins, lower in calcium, and generally deficient in carotene (provitamin A). Thus, where non-legume roughages are used for extended periods, these nutritive deficiencies should receive consideration. This is especially important with the gestating-lactating cow or the young, growing calf. For these reasons, where dry and bleached pastures are grazed for an extended period of time or when there is an unusually long winter, it is important that at least a part of the roughage be a legume, either silage or hay. It is also more necessary that careful consideration be given to providing suitable protein and mineral supplements.

Silages and Roots For Beef Cattle

Silage is an important adjunct to pastures in beef cattle production, it being possible to use a combination of the two forages in furnishing green, succulent feeds on a year-round basis. Extensive use of silage for beef cattle only dates back to about 1910. Prior to that time, it was generally thought of as a feed for dairy cows. Even today, only a relatively small percentage of the beef cattle of the United States are fed silage.

Where silage has been used, it has proved quite popular. Some of the more important reasons advanced in favor of silage are as follows:

1. On most beef cattle producing farms, silage is the cheapest form in which a good succulent winter feed can be provided.
2. It is the cheapest form in which the whole stalk of an acre of corn or sorghum can be processed and stored.
3. Good silage can be made during times of rainy weather when it would be impossible to cure properly hay or fodder.
4. It helps to control weeds, which are often spread through hay or fodder.
5. Silage is a better source of vitamins, especially carotene and perhaps some of the unknown factors, than dried forages.
6. There is no danger of fire loss to silage.
7. Silage is a very palatable feed and slightly laxative in nature.
8. Converting the crop into silage clears the land earlier than would otherwise be possible.

9. Silage makes for less waste, the entire plant being eaten th relish.

10. The removal of corn stalks, as is required in making age, is one of the best methods of controlling the European rn borer.

11. Silage increases the number of animals that can be pt on a given area of land.

Corn was first and still remains the principal crop used in e making of silage, but many other crops are ensiled in vari- s sections of the country. The sorghums are the leading ensil-



Fig. 171. Iowa cattlemen feeding corn silage. On most beef cattle tablishments, silage is the cheapest form in which a good succulent winter ed can be provided. (Courtesy, Wallace's Farmer and Iowa Homestead.)

ge crop in the Southwest; sunflowers are extensively ensiled in ie Northwest; and grasses and legumes are the leading ensilage ops in the Northeast. In fact, most any green or succulent crop ay be ensiled. In addition to those crops already mentioned, different sections of the country to which they are adapted, ie following feeds are ensiled: cereal grains, field peas, cowpeas, ybeans, potatoes, and numerous fruit and vegetable refuse oducts.

In feeding silage to cattle, it must be remembered that, be- use of its high moisture content, about three pounds of silage

are generally considered equivalent to one pound of dry roughage of comparable quality. Fifty-five to sixty pounds of corn silage plus one-half to three-fourths pound of protein concentrate daily will carry a dry cow through the winter. The ration may be improved, however, by replacing one-third to one-half of the silage with an equivalent amount of a dry roughage, adding one pound of dry roughage for each three pounds of silage replaced.

Silage may also be successfully used for fattening steers. Two-year-old steers will eat thirty to forty-five pounds a day at the beginning of the feeding period, the larger amounts being consumed when no hay is fed with it. Better results are secured, however, if hay is included in the ration. The amount of silage is gradually decreased as the concentrates are increased. At the end of the feeding period, the cattle should be getting around fifteen to eighteen pounds of silage and two or three pounds of hay, or eighteen to twenty pounds of silage if no hay is fed. Because of the more limited digestive capacity, the allowance of silage fed to calves or yearlings should be correspondingly less.

Usually, silage provides a much cheaper succulent feed for beef cattle than roots. For this reason, the use of roots for beef cattle is very limited, being confined almost entirely to the northern districts.

Concentrates For Beef Cattle

The concentrates include those feeds which are low in fiber and high in nutritive value. For purposes of convenience, concentrates are often further classified as (1) carbonaceous feeds and (2) nitrogenous feeds. The chief carbonaceous feeds used for beef cattle are the cereal grains and such processed feeds as hominy feed, beet pulp, and molasses. The leading nitrogenous or high protein feeds utilized by beef cattle in this country are cottonseed meal or cake, linseed meal or cake, cottonseed, soybean meal, soybeans, peas, wheat bran, and corn-gluten meal and feed.

In general, the use of concentrates for beef cattle is limited to (1) the fattening of cattle, (2) the development of young stock, and (3) use as limited supplements in the wintering ration. Over most of the United States the cereal grains are the chief concentrates fed to beef cattle, these grains being combined, if necessary, with protein supplements to balance the ration. The choice of the particular grain or grains is usually determined by price and availability.

For best results the feeder should correct the nutritive iciencies of the cereal grains. All of these feeds are low in tein, low in calcium, and lacking in vitamin D. All except yel- corn are also deficient in vitamin A. Regardless of whether cereal grains are fed to growing, breeding, or fattening ani- ls, their nutritive deficiencies can be corrected in a very effec- e and practical way by either adding (1) a good quality of ume hay to the ration or (2) a protein concentrate plus a table mineral source of calcium.

It is now known that a considerable portion of the protein sumed by cattle may be built into new nitrogenous compounds the body of the microorganisms in the paunch, which in turn digested and utilized by the cattle. Consequently, the use of re expensive and complete protein supplements of animal gin is not necessary in feeding cattle. But even the protein centrates of plant origin are usually more expensive than ne-grown legume hays as a source of proteins. Moreover, they k the calcium and vitamins of the latter.

Where home-grown legume hays are not available, the selec- n of a protein concentrate should be determined largely by ce and availability. Because protein feeds are usually higher price than carbonaceous feeds, normally one should include the ration only sufficient protein concentrates to balance the ion. Naturally, the amount will vary, especially according to age of the animals and the kind and amounts of other feeds ilable.

EDING THE HERD BULLS

The feeding program for the herd bull should be such as to p him in a thrifty, vigorous condition at all times. He should ther be overfitted nor in a thin, run-down condition. In season, nutritive requirements for the mature herd bull can usually met through good pastures. With the young bull, during the eding season or winter months, adequate grain and roughage uld be provided. Usually, the bull is kept separate from the herd except during the breeding season.

EDING THE BEEF BREEDING COWS

Heavy grain feeding is uneconomical and unnecessary for beef breeding herd. The nutrient requirements should merely adequate to provide for maintenance, growth (if the animals immature), and reproduction. Fortunately, these require- nts can largely be met through the feeding of cheap roughages.

Feeding the Dry and Pregnant Cows

Breeding cows should neither be permitted to get overfat nor in a thin, run-down condition. The best calf crop is secured from cows that are kept in vigorous breeding condition. Usually, the pregnant cow should gain in weight sufficient to account for the growth of the fetus (sixty to ninety pounds). In addition, she should slightly increase her body weight to carry her through the suckling period. Most of her feed should consist of pasturage and other home-grown roughages such as silage or root crops and hay.

Except during the winter months, there is no finer place for the breeding cows than the run of a pasture or range. Aside from supplying the necessary nutrients at low cost, this system provides much valuable exercise. Should the pasture become very short—because of droughts, deep snow, or over-grazing—a supplemental feed of silage, dry forage crops, or concentrates should be provided.

The winter feeding period is the most expensive, necessitating good management in order to hold down the cost. The cheaper home-grown roughages should constitute the bulk of the winter ration for dry or pregnant cows. Most of the grain and the higher class roughages then may be used by other classes of livestock. A practical ration may consist of silage or root crops and dry roughages (legume or grass hays) combined with a small quantity of protein-rich concentrates (such as linseed meal or cottonseed meal). With the use of a leguminous roughage, the protein-rich concentrate may be omitted. Dusty or moldy feed and frozen silage should be avoided in feeding all cattle but especially in the case of the pregnant cow, for such feed may produce complications and possible abortion. Feeding in the fall should not be delayed so long that the cows begin to lose weight. Furthermore, the herd should be fed in the spring until the grass has attained sufficient growth and substance.

Proper developing of the fetus requires an abundance of calcium. When legume hays are fed, this need is usually met. However, when non-legumes are being utilized, it is wise to provide free access to a calcium mineral such as ground limestone or feeding steamed bone meal. Bone meal should be selected for most conditions for the reason that it will take care of both the calcium and phosphorus needs. In addition, plenty of salt should be available at all times.

ding at Calving Time

Proper feeding at calving time is very important. If the es are dropped out on a pasture or range where both forage water are reasonably accessible, cows will satisfactorily regu- their own needs. On the other hand, when inclement weather ther conditions make it necessary to confine the cow at calv- time, the skill and good judgment of the caretaker becomes atter of importance. Under such unnatural conditions of con- ment, the cow may be watered at frequent intervals immedi- y before and after calving, but in no case should she be wed to gorge. It is also a good plan to take some of the chill the water in the winter time. It is considered good practice ed lightly and with laxative feeds during this period. A satis- ory ration at calving time may consist of a mixture of bran oats, together with a generous allowance of hay. The quan- of feed given should be governed by the milk flow, the lition of the udder, the demands of the calf, and the appetite condition of the cow.

ding the Lactating Cows

Up until weaning time, at approximately six months of age, growth of the calf is chiefly determined by the amount of available from its dam. The principal part of the calf's on, therefore, may be cheaply and safely provided by giving



Fig. 172. Hereford cows and calves on pasture at the University of aska. In season, green succulent pastures afford the most effective and ical way in which to stimulate milk production. (Courtesy, C. B. & Q. oad Company.)

its mother the proper feed for the production of milk. In season, green, succulent pastures afford the most effective and practical way in which to stimulate lactation. When pastures are scanty or during the winter months, grain and protein supplement feeding of both the dam and the calf may be essential.

Dual-purpose cows that are producing market milk as well as calves should receive feeds nearly identical to those provided for dairy cows in the same area. Generally speaking, they should be fed one pound of concentrates for every three to four pounds of milk produced, the exact amount depending upon the fat content of the milk.

FEEDING GRAIN TO SUCKLING CALVES

The vast majority of calves are raised on their mother's milk plus whatever pasture or other feed they share with their dams. If calves are to be marketed at weaning time or soon thereafter, if they are to be fattened as baby beeves, or if they are to be sold as purebred stock, liberal grain feeding should be started at the earliest possible age. Calves handled in this manner will have a greater selling weight and more finish when they are marketed. Even when calves are not to be marketed at an early age—when fattened over a longer feeding period or when carried as stockers—they should be taught to eat grain and hay so that the transition during weaning will not result in loss of flesh. Likewise, calves from dual-purpose cows from which market milk is to be produced should be taught to eat supplemental feeds within a few weeks after birth. Calves may be fed grain in a creep in the pasture or in a lot separate from their mother's and should be allowed to nurse twice daily. Since the latter practice involves more labor, "creep" feeding is usually resorted to for feeding calves on pasture.

Creep Feeding Calves

A "creep" is an enclosure for feeding purposes made accessible to the calves but through which the cows cannot pass. This allows for the feeding of the calves but not the dams. For best use, the "creep" should be built at a spot where the herd is inclined to loiter. The ideal location is on high ground, well drained, in the shade, and near the place of watering. Keeping the salt supply nearby will be helpful in holding the cow herd near the creep.

It is important that calves be started on feed very carefully. At first only a small amount of feed should be placed in the

ghs each day, any surplus feed being removed and given to cows. In this manner, the feed will be kept clean and fresh, the calves will not be consuming any moldy or sour feed. en calves are on luxuriant pasture and their mothers are ing well, difficulty may be experienced in getting them to

In experiments at Sni-A-Bar Farms comparing creep-fed es with calves allowed to nurse the cows without grain, it found that Shorthorn calves fed $8.97 worth of grain in a



Fig. 173. A calf creep in use on the Malone Polled Hereford Ranch, dian, Mississippi. This arrangement allows for the grain feeding of the s but not the dams. (Courtesy, National Cottonseed Products Associa- Inc.)

ep" on pasture during the nursing period averaged one hun- pounds heavier at weaning time than similar calves allowed urse the cows without grain. In addition, these creep-fed es were worth $2.00 per hundred or $17.88 per head more the calves that received no grain.[1]

EDING STOCKERS

Stockers are young heifer replacements or steers and heifers are intended for market and which are being fed and cared in such manner that growth rather than fattening may be zed. Because of the very nature of the operation, the success- feeding of stockers requires the maximum of economy con-

[1] Experiments conducted by the U. S. Dept. of Agri. and the Missouri . Sta. in cooperation with Sni-A-Bar Farms of Grain Valley, Missouri.

sistent with normal growth and development. This necessitates cheap feed—either pasture or range grazing or such cheap harvested roughages as hay, straw, fodder, and silage. In general, the winter feeds for stockers consist of the less desirable and less marketable roughages.

The feed consumption of stockers will vary somewhat with the quality of the roughage available, the age of the cattle, and the rate of gain desired. Usually, the daily gains should range from three-fourths to one and one-fourth pounds. If a young, rapidly-growing stocker calf is not gaining at least three-fourths of a pound daily, he will lose too much in condition.

FEEDING FATTENING CATTLE

The fattening of cattle is what the term implies, the laying on of fat. The ultimate aim of the fattening process is to produce meat that will best answer the requirements and desires of the consumer. This is accomplished through an improvement in the flavor, tenderness, and quality of the lean meat which results from "marbling." Furthermore, fat adds to the digestibility and nutritive value of the product.

In a general way, there are two methods of finishing cattle for market: (1) dry-lot fattening and (2) pasture fattening. Prior to 1900, the majority of fat cattle sent to the market were four- to six-year-old steers that had been fattened primarily on grass. Even today, the utilization of pastures continues to play an important part in all types of cattle-feeding operations.

Dry-Lot Fattening

As might be expected, dry-lot fattening has shown its greatest development in the Corn Belt states. This may be attributed to the proximity of the central states to the feeder cattle supply of the western ranges and the great amount of corn and other fattening feeds produced on the productive farms of this area. Even in the Corn Belt, however, cattle are usually carried on pasture for a part of the fattening period.

Approximately one-third of all the feeder cattle of the western range area are shipped into the Corn Belt for fattening. In addition, many of the farms in the central states produce feeder cattle which are finished out on the same farm or a farm in the general area.

Approximately four million cattle are grain-fattened annually in the Corn Belt with the following breakdown by states:



Fig. 174. Hereford cattle being dry-lot fattened on the farm of John urt, Cascade, Iowa. About four million cattle are grain-fattened anly in the Corn Belt. (Courtesy, The Corn Belt Farm Dailies.)

cent in Iowa, 16 per cent in Illinois, 11 per cent in Nebraska, er cent in Missouri, 9 per cent in Minnesota, 8 per cent in sas, 5 per cent in Indiana, and the remaining 13 per cent Ohio, Michigan, South Dakota and Wisconsin.

In dry-lot feeding, the selection of the roughage varies from to area. Among the most common roughages used in fattenrations are: legume hays, silages, grass-legume mixed or ss hays, and various stovers and fodders. Where good legume s are home grown or are available at a reasonable cost, they e a very satisfactory forage, supplying the necessary pros, calcium, and vitamin A for the dry-lot ration. The maximuse of silage can best be obtained early in the fattening od or with more mature steers that possess a larger digestive acity. Whenever either a non-legume dry forage or silage is l in fattening steers, a protein supplement should be added he ration.

Generally speaking, the choice of a protein supplement uld be determined by the comparative prices of a pound of ein in the available supplements. As protein supplements of nal origin are usually more expensive and no more effective steers than proteins of plant origin, the latter are usually The leading protein supplements for fattening cattle are

linseed oil meal, cottonseed oil meal, and soybean oil meal. Where a good quality legume roughage is used, it is not necessary to add a protein supplement to the ration of fattening cattle or even to that of calves. When non-legume roughages are used, however, a protein supplement should be added to the ration—usually somewhere between one-half to one and one-half pounds of supplement per head daily—the exact amount depending upon the kind of roughage and grain and the age of the cattle. Naturally, calves have a higher protein requirement. As protein concentrates are usually expensive, it is not economical to add more than is required to balance the ration.



Fig. 175. Steers eating beet tops in feed yard near Torrington, Wyoming. In the sugar-beet areas, beet tops, beet pulp (dry or wet), and beet molasses are used extensively. (Courtesy, C. B. & Q. Railroad Co.)

Although corn is by far the most common grain used in fattening steers, such cereal grains as barley, rye, oats, and wheat are used in many sections of the northern and Pacific Coast states. In the Southwest, the grain sorghums predominate both as grain and silage. In the sugar-beet areas, beet pulp (dry or wet), beet tops, and molasses are used extensively; whereas in the Cotton Belt, cottonseed meal and hulls make up the standard cattle-fattening ration. Rye may be used if limited to not more than one-third of the grain ration. Because of the bulk, oats and dried beet pulp should not make up more than one-half of the ration and preferably not more than one-third. Wheat and oats are frequently too expensive to include in the cattle-fattening ration.

Barley seems to cause more bloat than most concentrates. For this reason, it is well that the other grains and the rough-

be carefully selected when it seems desirable to include siderable barley in the ration. A mixture of barley, dried pulp, and oats is commonly used in the West. It is best not se a straight legume hay along with a grain ration high in ey.

Beet by-products are notoriously low in phosphorus. For best lts, therefore, a suitable phosphorus mineral supplement, as steamed bone meal, should be provided where these feeds used extensively.

Cottonseed meal and hulls are very deficient in vitamin A. en cattle are fed heavily on these products, they may develop ous deficiency symptoms, formerly known as "cottonseed l poisoning." This condition may be averted by adding a d source of carotene—such as green, leafy alfalfa hay or ow corn—to rations high in cottonseed by-products.

In the final analysis, the choice of the concentrate ration uld be determined largely by the availability and price of ls. The experienced cattle feeder generally figures that it will e fifty bushels of corn (or an equivalent amount of another in) and one-half ton of good quality legume hay to fatten eef steer to Choice grade regardless of its age. Younger ani- s require a longer time in which to consume this feed and ch approximately the same degree of finish. When silage is d, it may be assumed that about three pounds of silage will lace one pound of hay.

Cattle fattening in the dry-lot should have free access to . Also, when a non-legume is used, a mineral source of cal- n should be provided. Phosphorous is not likely to be deficient attening rations, except when liberal quantities of beet by- ducts are being fed.

Occasionally vitamin A is lacking in dry-lot rations. This specially true under conditions when bleached roughages are or the ration contains liberal amounts of cottonseed by- ducts. Yellow corn and green, leafy hays are good feed-lot rces of vitamin A.

ture Fattening

Where grazing land is extensive and not too high in price, tures no doubt will continue to be utilized in finishing cattle market. Cattle finished on grass may not make quite such id gains or reach the same high degree or quality of finish cattle fattened on grain. Moreover, grass-finished cattle do not mand the values of grain-finished cattle. Yet when grass is

plentiful and cheap, one can usually afford to sacrifice in gain, finish, and selling price because of the much lower cost of production.

In farming districts where there is much rough waste-land unsuited to tillage and where high grain prices prevail (because of shipment from distant areas), the fattening of cattle on grass (with or without supplements) is common, for pastures are then utilized to the maximum. On the other hand, in districts where there is but little untillable land, where more feed can be produced on an acre of tilled crops than on an acre of pasture, or



Fig. 176. Yearling Hereford steers from Texas, fattening on bluestem grass in the famous grazing area in the Kansas Flint Hills. (Courtesy, Dr. A. D. Weber, Kansas State College.)

where land is high in price, dry-lot fattening is more common. Even in the so-called dairy sections of the United States, there are many cheap, isolated pasture areas that are not now being effectively utilized for dairy production or other enterprises but which seem admirably adapted to a system of beef production in which pastures may be utilized to the maximum.

Regardless of the area, it can be said without fear of contradiction that no cheaper method of harvesting forage crops has yet been devised than is afforded by harvesting directly by grazing animals. Moreover, even most seeded pastures last several years; thus seeding costs may be distributed over the entire period. Naturally the cash income to be derived from pastures will vary from year to year and from place to place depending upon such factors as market price levels, class of animals, soil, season, and the use of adapted varieties.

VANTAGES AND DISADVANTAGES PASTURE FATTENING:

The advantages of fattening cattle on pasture, compared trictly dry-lot fattening, are:

1. Pasture gains are cheaper because: (1) less grain is iired per one hundred pounds gain; (2) grass is a cheaper ghage than hay or silage; and (3) less expensive protein olement is required.

2. Less labor is required because the cattle gather their roughage and the labor required for feeding roughage is inated. In brief, grass-fattened cattle do their own harvest- Furthermore, it may be possible to get satisfactory results h but one grain feeding each day in fattening on pasture, he animals may be self fed, with the caretaker merely filling feeder at intervals.

3. Pigs following steers on pasture make better gains than following steers under dry-lot conditions.

4. The maximum fertility value of the manure is conserved, handling of the manure is eliminated. When pastures are ized by livestock, approximately 80 per cent of the plant rients of the crop is returned to the soil.

5. Pasture fattening eliminates any requirement for build- s.

The disadvantages of fattening cattle on pasture, compared trictly dry-lot fattening, are:

1. Most feeder cattle are marketed in the fall rather than he spring. Therefore, feeder steers purchased in the spring intended for pasture fattening are usually scarce and high rice.

2. Though less labor is required, less labor is available. The pping season is a rush season.

3. During the midsummer, the combination of heat and s may cause much discomfort to the animals and reduce the ns made.

4. Pastures may become dry and parched, reducing the ns made during dry seasons.

5. The manure is usually dropped on permanent pastures r after year, which may result in the neglect of the other ds.

6. In many pastures, availability of shade and water does present a problem. However, some areas are less fortunate his regard.

After both the advantages and disadvantages of pasture fattening are considered, the availability of cheap, rough pasture land and the price of concentrates will usually be the determining factors in deciding upon the system to follow.

SYSTEMS OF PASTURE FATTENING:

When cattle are finished on pasture, any one of the following systems may be employed:

1. Fattening on pastures alone—no concentrates being fed.
2. Limited grain allowance during the entire pasture period.
3. Full feeding during the entire pasture period.
4. Full or limited grain feeding on pasture following the period of peak pasture growth.
5. Short feeding (70 to 120 days) in the dry lot at the end of the pasture period.

The system of pasture finishing that will be decided upon will depend upon the age of the cattle, the quality of the pasture, the price of concentrates, the rapidity of gains desired, and the market conditions.

PREVENTION OF BLOAT ON PASTURES:

There is always a possibility that bloat will occur when appreciable amounts of legumes are grazed. Even so, the high productivity of grass-legume mixtures usually makes their use profitable—especially for commercial cattle—provided that proper precautions are taken to minimize the danger from bloat.

The following practices will be helpful in reducing the bloat hazard:

1. In order to prevent the animals from filling up too rapidly on the green material, give a full feed of hay or other dry roughage before the animals are turned to legume pastures.
2. If possible, after the animals are once turned to pasture, they should be left there continuously. If the animals must be removed over night or for longer periods, they should be filled with dry roughage before they are returned to the pasture.
3. Mixtures that contain approximately half grasses and half legumes should be used.
4. Water and salt should be conveniently accessible at all times.
5. The animals should not be allowed to become empty when they congregate in a dry lot for shade or insect protection and then be allowed to gorge themselves suddenly on the green forage.

6. Many practical cattlemen feel that the bloat hazard is ced by mowing alternate strips through the pasture, thus ving the animals to consume the dry forage along with the ure. Others keep in the pasture a rack well filled with dry or straw.

7. Because of the many serrations on the leaves, sudan hay ars especially effective in preventing bloat when fed to cattle gume pastures.

Although the cause of bloat has not been scientifically estab-d, it appears that anything that will tickle the animal's hing mechanism—thus causing it to belch rather than per-ing it to blow up like a balloon—will reduce the hazard. rse dry roughages appear to have this effect.

Feeder's Margin

By "margin" is meant the difference between the cost per dredweight of the feeder animals and the selling price per dredweight of the same animal when fattened. Gains made ne feed lot are expensive. They generally cost more per pound roduce than the selling price per pound obtained at marketing e. In order to cover this loss and secure a profit on the opera-s, the cattle must sell at a higher price per pound than was for them. This spread in price is commonly referred to as "necessary margin."

CTORS DETERMINING THE NECESSARY MARGIN:

The factors that determine the necessary margin are as ows:

1. A smaller margin is necessary in the case of cattle ing a greater initial weight. This is due to the fact that there greater weight to sell on whatever margin may exist.

2. Better grades of cattle can be handled on smaller mar-s than can poorer grades. This is due to the higher selling e of the gains secured.

3. The greater the cost of gains, the greater the necessary gin. This is due to the high cost of gains as compared to r selling value.

4. The longer the feeding period and the greater the gains essary to get the cattle in a finished condition, the greater margin. This is also due to the fact that gains made in the l lot are expensive, generally costing more to produce than be realized in selling on the market.

Considering all the above factors collectively, it may be erstood why less margin is necessary in the case of heavy,

mature steers carrying considerable flesh when purchased as compared with thin, light-weight yearlings. Calves usually require the smallest margin of all because of their efficiency of gains and their higher value per hundredweight.

Fattening Cattle of the Various Market Grades

The most profitable grade of cattle to feed will generally be that kind of cattle in which there is the greatest spread of margin between their purchase price as feeders and their selling price as fat cattle. As can be readily understood, one cannot arrive at this decision by merely comparing the existing price between the various grades at the time of purchase. Rather, it is necessary to project the differences that will probably exist, based on past records, when the animals are fat and ready for market.

As very few grain-fed cattle are marketed in the summer and fall, the spread in price between Good to Choice fat cattle and those of the lower grades is usually the greatest during this season. On the other hand, the spread between these grades is likely to be least in late winter and early spring, when a large number of well-fattened cattle are coming to market from the feed lots.

The length of the feeding period and the type of feed available should also receive consideration in determining the grade of cattle to feed. Thus for a long feed and when a liberal allowance of grain is to be fed, only the better grades of feeders should be purchased. On the other hand, when a maximum quantity of coarse roughage is to be utilized and a short feed is planned, cattle of the medium or lower grades are most suitable.

Cattle of the lower grades should be selected with very special care in order to make certain that only thrifty animals are bought. Ordinarily, death losses are much higher among low-grade feeder cattle, especially when the low-grade animals are calves. The death loss in handling average or high-grade feeders seldom exceeds 1 to 2 per cent; whereas with "Cull" or "dogie" cattle, it frequently is twice or three times this amount. Many low-grade cattle are horned, and dehorning further increases the death risk—in addition to the added labor and shrinkage resulting therefrom.

No given set of rules is applicable under any and all conditions in arriving at the particular grade of cattle to feed, but the following factors should receive consideration.

1. The feeding of high-grade cattle is favored when:
 a. The feeder is more experienced.
 b. When a long feed with a maximum of grain in the ration is planned.
 c. When conditions point to a wide spread in price between grades at marketing time. Such conditions normally prevail in the late summer or early fall.
2. The feeding of average or low-grade cattle is favored n:
 a. The feeder is less experienced.[1]
 b. When a short feed with a maximum of roughage or cheap by-products is planned.
 c. When conditions point to a narrow spread in price between grades at marketing time. Such conditions normally prevail in the spring.
3. In addition to the profit factors enumerated above, it ıld be pointed out that with well-bred cattle the following itions prevail:
 a. Well-bred cattle possess greater capacity for consuming large quantities of feed than steers of a more common grade, especially during the latter part of the feeding period.
 b. The higher the grade of cattle, the higher the dressing percentage and the greater the proportionate development of the high-priced cuts.
 c. The higher the grade of the cattle, the greater the opportunities for both profit and loss.
 d. There is a greater sense of pride and satisfaction in feeding well-bred cattle. To top the market with a load of Prime steers is frequently more gratifying and means more to an experienced and self-respecting feeder than any greater profits that might be derived from feeding low-grade cattle.

Certainly the producer who raises his own feeder cattle ıld always strive to breed high-grade cattle regardless of ther he fattens them out himself or sells them as feeders. the other hand, the purchaser of feeder steers can well afford ully appraise the situation prior to purchasing any particular le.

[1] In general, the inexperienced feeder should stick to the middle kind leave the extremes—the fancy and the plain cattle—to the man with rience.

The Value of Breeding and Type in Fattening Cattle

Although the supporting data is rather limited, it is fully realized that there is considerable difference between individual animals insofar as rate and economy of gain is concerned. It is to be emphasized that these differences are greater within breeds than between breeds.

In studies at the Wisconsin Experiment Station, feeding trials were conducted with purebred Aberdeen-Angus, purebred Holsteins, and cross-bred Angus-Holstein calves of approximately the same age. The Wisconsin investigators found that the particular Holsteins used produced slightly more rapid and economical gains than were obtained with the purebred Aberdeen-Angus, with the cross-breds intermediate between the two. However, the beef-type animals had a higher dressing percentage and a more desirable quality of carcass, with a greater proportion of valuable cuts of meat. Thus the animals of beef type and breeding brought a higher market price. The average selling price for the Aberdeen-Angus steers was $13.00 in comparison with $12.16 for the cross-breds and $10.08 for the Holsteins.[1]

The Wisconsin studies would again lend credence to the statement that the breeder should always strive to produce beef-type cattle of good breeding. On the other hand, where replacement calves are not needed in the dairy herd, it may often be advantageous to use a beef-type bull as a "cow freshener"—thus securing a calf which is more valuable either as a veal or as a potential feeder. There may, however, be sufficient spread in price between the grades to warrant that the purchaser of feeder steers shop about when considering the particular grade of cattle to choose.

Age as a Factor in Fattening Cattle

A generation ago the term "feeder steer" signified to both the rancher and the Corn Belt feeder a two-and-one-half to three-year-old animal weighing approximately one thousand pounds. Today, feeder steers are referred to by ages as "feeder calves," "yearlings," and "two-year-olds." This shift to younger cattle has been brought about primarily by the consumer demand for smaller and lighter cuts of meat.

The particular age of cattle to feed is one of the most important questions to be decided upon by every practical cattleman

[1] J. G. Fuller, Wisc. Agr. Expt. Buls. Nos. 396, 405, and 410; see also Fuller, J. G., Soc. Anim. Prod., Proc. 1930.

following factors should be considered in reaching an intelli-
t decision on this point:

1. **Rate of gain.**—When cattle are fed liberally from the
e they are calves, the daily gains will reach their maximum
first year and decline with each succeeding year thereafter.
the other hand, when in comparable condition, thin but
lthy two-year-old steers will make more rapid gains in the
l lot than yearlings, and likewise yearlings will make more
d gains than calves.

2. **Economy of gain.**—Calves require less feed to produce
hundred pounds of beef than do older cattle. This may be
lained as follows:

a. The increase in body weight of older cattle is largely due to the deposition of high-energy fat, whereas the increase in body weight of young animals is due, in part at least, to the growth of muscles, bones, and vital organs. Thus the body of a calf at birth usually consists of more than 70 per cent water, whereas the body of a fat two-year-old steer will only contain 45 per cent moisture. In the latter case, a considerable part of the water has been replaced by fat deposition.

b. Calves consume a larger proportion of feed in proportion to their body weight than do older cattle.

c. Calves masticate and digest their feed more thoroughly than older cattle. Despite the fact that calves require less feed per one hundred pounds gain—because of the high-energy value of fat—older cattle store as much energy in their bodies for each one hundred pounds of total digestible nutrients consumed as do younger animals.

3. **Flexibility in marketing.**—Calves will continue to make
isfactory gains at the end of the ordinary feeding period,
ereas the efficiency of feed utilization decreases very sharply
en mature steers are held past the time that they are finished.
erefore, under unfavorable market conditions, calves can be
cessfully held for a reasonable length of time, whereas pro-
ging the fattening period of older cattle is usually unprofitable.

4. **Length of feeding period.**—Calves require a somewhat
ger feeding period than older cattle to reach comparable finish.
rder to reach Choice to Prime condition, steer calves must be
fed from eight to nine months, yearlings six to seven months,
two-year-olds only from five to six months. The longer fat-

tening period required for calves is due to the fact that they are growing as well as fattening.

5. **Total gain required to finish.**—In general, calves must put on slightly more total gains in the feed lot than older animals in order to attain the same degree of finish. In terms of initial weight, calves practically double their weight in the feed lot; yearlings increase in weight approximately 70 per cent; and two-year-olds increase their initial feed lot weight by from 40 to 50 per cent.

6. **Total feed consumed.**—The daily feed consumption of calves is considerably less than for older cattle, but as calves must be fed for a slightly longer feeding period, the total feed requirement for the entire fattening period is approximately the same for cattle of different ages.

7. **Experience of the feeder.**—Young cattle are bovine "babies." As such, they must be fed more expertly. Thus the amateur feeder had best feed older cattle.

8. **Kind and quality of feed.**—Because calves are growing, it is necessary that they have more protein in the ration. Normally, protein supplements are higher in price than carbonaceous feeds, thus making for a more expensive ration. Also, because of the smaller digestive capacity, calves cannot utilize as much coarse roughage, pasture, or cheap by-product feeds as older cattle.

Calves also are more likely to develop peculiar eating habits than older cattle. They may reject coarse, stemmy roughages or moldy or damaged feeds that would be eaten readily by older cattle. Calves also require more elaborate preparation of the ration and attention to other small details designed to increase their appetite.

9. **Pigs following cattle.**—Because calves masticate and digest their feed more thoroughly than older cattle, the amount of pork secured from pigs following fattening cattle varies directly with the age of the cattle.

10. **Comparative costs and selling price.**—Calves usually cost more per one hundred pounds as feeders than do older cattle. They also usually sell for a higher price per hundredweight as finished cattle.

11. **Dressing percentage and quality of beef.**—Older cattle have slightly higher dressing percentage than fat calves or baby beef. Moreover, many consumers have a decided preference for the greater flavor of beef obtained from older animals.

From the above discussion, it should be perfectly clear that ere is no best age of cattle to feed under any and all conditions. ther, each situation requires individual study and all factors st be weighed and balanced out.

ifers versus Steers

On the market, cattle are divided into five sex classes: steers, fers, cows, bulls, and stags. The sex of feeder cattle is impor- t to the producer from the standpoint of cost and selling ce (or margin), the contemplated length of feeding period, ality of feeds available, and ease of handling. The consumer is scious of sex differences in cattle and is of the impression t it affects the quality, finish, and conformation of the carcass.

Steers are by far the most important of any of the sex sses on the market, both from the standpoint of numbers and ir availability throughout the year, whereas heifers are sec- l.

The relative merits of steers versus heifers, both from the ndpoint of feed lot performance and the quality of carcass oduced, has long been a controversial issue. Based on experi- nts[1] and practical observations, the following conclusions and luctions seem to be warranted relative to this question:

1. **Length of feeding period.**—Heifers mature earlier than ers and become fat sooner, thus making for a shorter feeding riod. In general, heifers may be ready for the market thirty forty days earlier than steers of the same age started on feed the same time. Usually a short feed of 90 to 120 days is ferable with heifers.

2. **Market weight.**—The most attractive heifer carcasses obtained from animals weighing 650 to 900 pounds on foot, wing good condition and finish but not so fat as to be patchy l wasty.

3. **Rate and economy of gain.**—Because of their slower e of growth, the feed lot gains made by heifers are usually newhat smaller and more costly than those made by steers of same age. This point, however, is usually of little practical portance, as steers must be fed for a longer period in order reach the same degree of finish.

4. **Price.**—Because of existing prejudices, feeder heifers be purchased at a lower price per pound than steers, but they

[1] Sleeter Bull, F. C. Olson, and John H. Longwell, *Effect of Sex, Length Feeding Period, and a Ration of Ear Corn Silage on the Quality of Baby f*, Ill. Agri. Expt. Sta. Bul. No. 355, 1930.

also bring a lower price when marketed. Thus the net return per head may or may not be greater with heifers.

5. **Carcass quality.**—In England there is no discrimination in price against well-finished heifers. In fact, the English argue that the grain of meat in heifer carcasses is finer and the quality superior. On the other hand, the hotels, clubs, and elite butcher shops of this country hold a decided prejudice against heifer beef.

Carefully controlled experiments have now shown conclusively that when heifers are marketed at the proper weight and degree of finish sex makes no appreciable difference in the dressing percentage, in the retail value of the carcasses, or in the color, tenderness, and palatability of the meat.

6. **Ease of handling in the feed lot.**—Because of disturbances at heat periods, many feeders do not like to handle heifers in the feed lot.

7. **Flexibility in marketing.**—If the market is unfavorable, it is usually less advisable to carry heifers on feed for a longer period than planned because of (1) possible pregnancies and (2) the fact that animals become too patchy and wasty.

8. **Effect of pregnancy.**—Packer buyers have long insisted that they are justified in buying fat heifers at a lower price than steers of comparable quality and finish because: (1) most heifers are pregnant and have a lower dressing percentage, and (2) pregnant heifers yield less desirable carcasses. In realization that the packer will lower the price anyway, many feeders make it a regular practice to turn a bull with heifers about three to four months before the market period. Such feeders contend that the animals are then quieter and will make better feed-lot gains. In a carefully controlled experiment designed to ferret out the facts of this controversy, the Illinois Experiment Station[1] compared open and bred heifers in a five-month feeding period with the following pertinent results:

a. The bred heifers were quieter and easier to handle in the feed lot.

b. The bred heifers possessed keener appetites.

c. The young pregnant heifers grew less and put on more fat.

d. When kept at the same level of feed consumption, pregnancy had no appreciable effect on average daily gain.

[1] R. R. Snapp and Sleeter Bull, *Effect of Pregnancy on Quality of Beef*, Ill. Expt. Sta. Bul. No. 508, 1944.

e. Pregnancy did not affect dressing percentage. This was bably due to the higher finish and the lighter hides, heads, nks, stomach and smaller "fill" of the pregnant heifers. These ors were sufficient to overcome the weight of the three to months' fetus which averaged thirty pounds.

f. The carcasses of the bred heifers were noticeably better hed.

g. The flank, loin-end, and round were lighter in the bred in the open heifers, but the other wholesale cuts were prac-lly the same in each group.

The results of the Illinois experiment would indicate that producer is entirely justified in breeding full-fed heifers three our months prior to the time of marketing. It would also that packers are not justified in buying such bred heifers lower price because of any alleged lower dressing percentage ifference in carcass quality.

Spayed heifers may make slightly better gains than open ers, but the difference is usually not sufficient to overcome loss resulting from the operation. Spaying, therefore, is prof-le only if the selling price is sufficiently higher to warrant cost of the operation and the risk involved.

The trade in feeder cows and heifers assumes considerable me only in the fall and early winter—at the close of the ing season when the farmer or rancher is culling his herd prior to the start of the wintering operations. When market itions are favorable and an abundance of cheap roughage is lable, cows may often be fed at a profit.

When there is considerable demand for cheap meats, the er may find it profitable to fatten bulls and stags. Usually difficult to purchase such animals in large numbers. Here, vith the fattening of cows, the feeder should plan to utilize maximum of cheap roughage.

dings and Equipment for Fattening Cattle

The equipment should be adequate and durable, but in no should it be elaborate, expensive, or of such type as to con-ute to a high overhead for maintenance. From the standpoint helter, it is difficult if not impossible to improve upon a barn hich the major portion of the first floor is given over to cattle which has grain storage bins along one side, silo and scales ither end, hay and straw storage above, and open sides to south or away from the direction of strong prevailing winds.

Even in cold climates the shelter for fattening cattle need not be constructed for warmth. Protection from wind, rain, and snow is all that is necessary. Fattening cattle on full feed unavoidably produce ample heat—through the mastication, digestion, and assimilation of their feed—to keep their bodies warm under all ordinary conditions without in the least diminishing the amount of nutrients available for fattening. In many western sections, especially where there is little winter rainfall, cattle are often fattened in open yards with no shelter whatsoever. At the most, only a natural windbreak is provided. In humid sections with mild winters, it may not pay to provide any shelter for fattening cattle.

In dry-lot feeding during the summer months, shelters provide desirable coolness and protection from insects. They also protect the animals from exposure to a blistering sun. Without such protection, the coats of the cattle are likely to become harsh and sunburned, thus lessening the attractiveness of the animals and lowering their sale value.

Covering the windows and draping the openings of the shed with burlap reduces trouble from flies.

Providing dry bedding makes for comfort of the animals and helps to conserve the manure, especially the urine.

Excess Fattening

During World War II, excess fattening was discouraged on the basis that it represented a needless waste of feed—and grains were desperately needed for human consumption for our fighting allies and in rehabilitating the war-torn countries. In order to reduce such waste of grains, the Prime grade of beef was eliminated. Moreover, O.P.A. meat controls were designed to favor the Good and Medium grades of beef rather than the Choice grade.

Excessive fattening is undesirable, both from the standpoint of the producer and the consumer. Feed-lot gains are always expensive, and experienced cattle feeders are fully aware of the fact that to carry fattening cattle to an unnecessarily high finish is usually prohibitive from a profit standpoint. This is true because the gains in weight then consist chiefly of fat and contain but little water. In addition, a very fat animal eats less heartily with the result that a small proportion of the nutrients, over and above the maintenance requirement, are available for making body tissue.

Beef should carry ample finish to make the meat attractive, y, and well flavored; but any fat in excess of these require- ıts is usually trimmed off. Because of this situation, one of real challenges to the beef cattle producer of the future is ›roduce animals which, from a genetics standpoint, are pre- ›osed to produce marbling without excessive exterior fat.

s Following Cattle

During normal years, many good Corn Belt cattle feeders amply repaid if they are able to: (1) market the grain



Fig. 177. Hogs following cattle. One pig should follow every one to e steers, the ratio of pigs varying with the kind and preparation of the and the age of the cattle. Sometimes the only profit obtained is in the s made by pigs following cattle. (Courtesy, The Farm Belt Dailies.)

›ugh cattle at prevailing prices, (2) retain the manure to put k upon the land, and (3) obtain as profit the gains made by s following cattle.

The cattle feeder should plan for one pig to follow every to three steers. The number of pigs will vary with the kind preparation of the feed and the age of the cattle being fed. nger cattle masticate their feed better than older cattle do, s providing less feed for pigs. Moreover, from one-third to -half as many pigs are needed when ground grains rather n whole grains are fed. The best pigs weigh from 50 to 150 nds and are active and not too fat.

TABLE 26

HANDY BEEF CATTLE FEEDING GUIDE

SUGGESTED RATIONS [With all rations and for all classes and ages of cattle, provide free access in separate containers to (1) salt (iodized salt in iodine-deficient areas) and (2) a mixture of ⅓ salt and ⅔ steamed bone meal.]	Wintering mature beef breeding cows	Wintering replacement heifers weighing 500 lbs. at start of wintering
	lbs. per day	lbs. per day
1. Legume hay or grass-legume mixed hay, good quality	18-28	[3]12-20
Grain		2-4
2. Grass hay or other non-legume dry roughage	18-28	[3]12-20
Grain		2-4
Protein supplement	½-1	1¼-1½
3. Legume hay or grass-legume mixed hay, good quality	7-11	[3]8-14
Grass hay or other non-legume dry roughage	11-17	4-6
Grain		2-4
Protein supplement		½-¾
4. Silage	55-60	[4]25-40
Grain		
Protein supplement	½-¾	1½-1¾
5. Silage	40-45	16-25
Legume hay or grass-legume mixed hay, good quality	5-6	3-4
Grain		
Protein supplement		1¼-1½
6. Silage	40-45	16-25
Grass hay or other non-legume dry roughage	5-6	3-4
Grain		
Protein supplement	½-¾	1¾-2

[1]If stocker calves are late or the roughage is fair to poor in quality it may be desirable to add 2 to 4 pounds of grain per head daily. If farm scales are available, monthly weights may be used as the criteria for grain feeding. Keep in mind that the calves should gain ¾ to 1 pound daily.

[2]In general, the experienced feeder plans that cattle on full feed shall receive about (1) two pounds of grain for each 100 pounds of live weight, and (2) two pounds of grain for each one pound of roughage. In areas where roughage is more abundant and comparatively cheaper than grain, as in the irrigated valleys of the West, the proportions of roughage to grain should be somewhat higher than indicated. In computing roughage consumption, three pounds of silage are considered equivalent to one pound of hay.

FEED ALLOWANCE AND SOME SUGGESTED RATIONS FOR BEEF CATTLE[1]

Some general rules of feeding may be given, but it must be remembered that "**the eye of the Master fattens his cattle.**" Nevertheless, the beginner may well profit from the experience of successful feeders. It is with this hope that the following general rules for feeding cattle are presented.

Table 26 is a Handy Beef Cattle Feeding Guide for different classes and ages of cattle. Also, some fitting rations follow. All of these are merely intended as general guides. Variations can and should be made in the rations used. The feeder should give consideration to (1) the supply of home-grown feeds, (2) the avail

[1]Grateful acknowledgment is given of the able assistance of three of the author's W.S.C. colleagues in the preparation of this section, especially the suggested rations. Mr. James Nofziger computed each ration, and Dr. Burch H. Schneider and Mr. Charles Kyd made many helpful suggestions and criticisms.

Where possible these rations were computed from the requirements as reported by the National Research Council and interpreted by the author

TABLE 26

HANDY BEEF CATTLE FEEDING GUIDE (Continued)

stockers d through d generally ollowing for winter 1 lb. per weighing s. start of ng).	[2]Fattening calves in dry-lot, generally in winter. (Weighing 400 to 500 lbs. start of feeding, and 650 to 750 lbs. at marketing).	Wintering yearlings; roughed through the winter, and generally pasture fattened the following summer. Fed for winter gains of 1 to 1¼ lbs. per head daily (weighing about 600 lbs. start of wintering).	[2]Fattening yearlings in dry-lot, generally in winter (weighing about 600 lbs. start of feeding and 750 to 900 lbs. at marketing).	[2]Fattening two-year-old steers in dry-lot, generally in winter (weighing about 800 lbs. start of feeding and 1,000 to 1,100 lbs. at marketing).
day	lbs. per day	lbs. per day	bs. per day	lbs. per day
8	5-6	16-24	6-8	8-12
...	10-12		12-18	15-20
8	4-5	16-24	6-8	8-12
...	8-12		11-16	15-20
½	1¾-2	1½-1¾	1¼-1½	1½-1¾
	2-3	6-8	2-3	3-5
	2-3	10-16	4-5	6-8
	7-11		11-16	15-20
½	1½-1¾	¼-½	¾-1	½-¾
0	12-15	45-55	18-24	24-36
...	6-10		11-16	15-20
¼	2-2¼	1¼-1½	1-1¼	1¼-1½
0	6-8	40-50	12-18	16-24
	2-3	2-4	2-3	3-4
...	6-10		11-16	15-20
1	1¾-2	¾-1	¾-1	¼-½
0	6-8	40-50	12-18	16-24
	2-3	2-4	2-3	3-4
...	6-10		11-16	15-20
½	2-2¼	1¼-1½	1-1¼	1-1¼

[1]With calves (both replacement heifers and stockers) an extra 2 lbs. of hay daily over and above requirements, rewith indicated in order to allow for wastage. Practical operators generally feed stemmy or other hay left-over lves to the cow herd.

[2]Practical operators report scouring and unsatisfactory gains where grass or legume silage only is fed to young . On the other hand, corn or sorghum silage properly balanced with a protein supplement appear to be entirely actory for young animals.

[3]A protein supplement is not so necessary for wintering stocker and feeder calves when good quality silage and quality legume hay are fed free choice.

lity and price of purchased feeds, (3) the class and age of tle, (4) the health and condition of the animals, and (5) the gth of the grazing season.

In using Table 26 as a guide, it is to be recognized that feeds similar nutritive properties can and should be interchanged price relationships warrant. Thus, (1) the cereal grains may nsist of corn, barley, wheat, oats, and/or sorghum; (2) the otein supplement may consist of soybean, cottonseed, and/or seed meal or cake; (3) the roughage may include many va-ties of hays and silages; and (4) a vast array of by-product eds may be utilized.

tting Rations for Cattle[1]

All animals intended for show purposes, including both eeding animals and fat steers, must be placed in a high state of

[1]Further information on selecting, fitting, and showing beef cattle is esented in Chapter XII of *Beef Cattle Husbandry*, a book by the same au-or and the same publisher as *Animal Science*.

condition. To accomplish this, a suitable ration must be selected and the animal or animals must be fed with care over a sufficiently long period. The rations listed are ones that have been used by successful showmen. They are higher in protein content than rations used in commercial-fattening operations, but most experienced herdsmen feel that by such means they get more bloom.

Rations 1 to 4 are bulky. They are recommended for use (1) by the inexperienced feeder, and (2) in starting prospective show animals on feed:

Ration No. 1

Ground barley	50 lbs.
Crushed oats	20 lbs.
Wheat bran	20 lbs.
Protein supplement[1]	10 lbs.

Ration No. 2

Ground corn	20 lbs.
Ground barley	30 lbs.
Crushed oats	20 lbs.
Wheat bran	20 lbs.
Protein supplement[1]	10 lbs.

Ration No. 3

Crushed oats	30 lbs.
Ground barley	30 lbs.
Ground corn	10 lbs.
Wheat bran	20 lbs.
Protein supplement[1]	10 lbs.

Ration No. 4

Crushed oats	30 lbs.
Ground corn	60 lbs.
Protein supplement[1]	10 lbs.

Rations 5 to 11 are less bulky and more fattening. They are recommended for use (1) by the experienced feeder, and (2) during the latter part of the fitting period:

Ration No. 5

Ground corn	40 lbs.
Crushed oats	30 lbs.
Wheat bran	20 lbs.
Protein supplement[1]	10 lbs.

Ration No. 6

Ground corn or sorghum chop	50 lbs.
Ground barley	40 lbs.
Protein supplement[1]	10 lbs.

Ration No. 7

Ground corn	60 lbs.
Crushed oats	20 lbs.
Dry beet pulp	10 lbs.
Protein supplement[1]	10 lbs.

Ration No. 8

Ground corn	40 lbs.
Ground barley	20 lbs.
Crushed oats	10 lbs.
Dried beet pulp	10 lbs.
Wheat bran	10 lbs.
Protein supplement[1]	10 lbs.

Ration No. 9

Crushed oats	25 lbs.
Ground barley	20 lbs.
Ground wheat	20 lbs.
Ground corn	20 lbs.
Wheat bran	10 lbs.
Protein supplement[1]	5 lbs.

Ration No. 10

Ground barley	35 lbs.
Crushed oats	20 lbs.
Ground wheat	20 lbs.
Dry beet pulp	15 lbs.
Protein supplement[1]	10 lbs.

Ration No. 11

Rolled barley	30 lbs.
Rolled oats	20 lbs.
Ground peas	10 lbs.
Rolled wheat	10 lbs.
Wheat bran	10 lbs.
Dried molasses beet pulp	10 lbs.
Linseed meal	8 lbs.
Soybean oil meal	2 lbs.

[1]The protein supplement may consist of linseed, cottonseed, or soybean cake; with pea-sized cake preferred to meal. With most herdsmen, linseed oil meal is the preferred protein supplement. It gives the animal a sleek hair coat and a pliable hide. Because it is a laxative feed, however, caution should be used in feeding it.

Ration 11 is used in fitting show steers at the State College Washington. To each 90 pounds of the grain mixture, the dsman adds 10 pounds of cooked barley—a highly palatable d. The cooked barley is prepared by (1) adding water in the portion of 2½ to 3 gallons to each gallon of dry barley, and cooking until the kernels are thoroughly swelled and can be ily squashed between the thumb and forefinger.

es of Feeding Show Cattle

As previously indicated, the selection of the particular fitting ion should be determined largely by the availability and price feeds. Make the maximum use of home-grown feeds. Other portant points in compounding the show ration and feeding the mal are:

1. Use care in getting the animal on feed. Avoid digestive turbances and set-backs. A safe plan consists in feeding not re than 1 pound of grain at the first feed, or 2 pounds for the . This may be increased approximately by ¼ to ½ pound ly until the animal is on full feed 3 to 4 weeks later.

From the beginning, it is safe to full-feed grass hay or the to which the animal is accustomed. Oats is the best concente for the beginning ration. As the grain feed is increased ording to the directions given above, gradually (1) replace the s with the mixed ration selected, and (2) decrease the hay, il the animal is eating only 3 to 6 pounds of hay daily at the of the feeding period.

2. When on full feed, the average animal will eat from 1½ 2½ pounds of grain for each 100 pounds of live weight. Feed y as much grain as the animal will clean up in ½ to 1 hour's e.

3. Feeds used in fitting rations should be coarsely ground or shed. Most herdsmen prefer steamed rolled grains.

4. Allow free access to a double compartment mineral box, h loose salt in one compartment and steamed bone meal (or ixture of 1/3 salt and 2/3 bone meal) in the other.

5. If the droppings are too thin or there is scouring, (1) cut vn on the grain allowance, and (2) clean up the quarters. If uble still persists, cut down on the legume roughage and the tein supplement (especially linseed oil meal). Many experied herdsmen prefer feeding grass or grass-legume mixed hay

to a straight legume hay, because of some difficulty in keeping forced fed animals on feed when a legume is fed.

6. The palatability of the ration may be enhanced by adding blackstrap molasses. Make it by diluting ½ to 1 pint of molasses with an equal volume of water and mixing it with each grain ration just before feeding. Although blackstrap molasses is preferable, beet molasses is satisfactory.

7. Nurse cows are costly, but they are used by most successful herdsmen in fitting young animals, especially animals under fifteen months of age.

CHAPTER XV

ENTRAL MARKETING AND PACKER SLAUGHTERING OF CATTLE AND CALVES

In the general chapter devoted to marketing livestock, it was inted out that livestock may be sold as follows: (1) to local yers, (2) to commission firms, (3) through cooperative mar- ting, (4) at community livestock auctions, (5) through direct arketing, (6) on the basis of carcass grade and weight, (7) to cal butchers and local feeders, (8) for home slaughter, and) as purebreds. Some cattle are marketed through each of ese channels, with the seller selecting the method which he els will be most remunerative for the particular kind and qual- of animals being marketed. Except for those animals that e sold as purebreds or stockers and feeders, the vast majority cattle are bought for immediate slaughter; and, even with rebreds or stockers and feeders, the ultimate objective is meat er the block.

Of the total livestock slaughtered in the United States in 48, 64 per cent of the cattle and calves, 66 per cent of the hogs, d 90 per cent of the sheep and lambs were slaughtered under deral inspection. The balance of slaughtering, that which is t under federal inspection, consists of farm slaughter and ughter at local plants. The vast majority of livestock slaugh- red in federally inspected plants is purchased on the central arkets rather than through direct buying; 75.6 and 60.2 per nt respectively of the cattle and calves were so obtained in 48.

Because most cattle and calves are sold through central arkets and are slaughtered by packers, the balance of this apter will be devoted to the subject of central marketing and cker slaughtering of cattle and calves.

EADING CATTLE MARKETS

With the development of the Corn Belt and western range ttle industry, the markets established at various points on the reat Lakes and along the Mississippi and Missouri rivers be- me important. It is logical that these should have remained ading cattle markets because of their proximity to both pro-

ducers and consumers. About 62 per cent of the cattle are raised west of the Mississippi, while about 70 per cent of the beef is consumed east of this geographical location.

Although the central markets vary from year to year in their total receipts, Chicago has long held undisputed lead as the world's greatest cattle market. Table 27 shows the largest cattle markets and their receipts of cattle.

LEADING CALF MARKETS

Upon the central markets cattle under approximately four hundred pounds in weight are designated as calves. As would be expected, many of these animals are of dairy breeding, especially the surplus bull calves that are not needed for breeding purposes. Of the remainder, a considerable number are culled out from beef



Fig. 178. Cattle buying scene on the Chicago market. Chicago has long held undisputed lead as the world's greatest cattle market. (Courtesy, Swift and Company.)

TABLE 27

CATTLE RECEIPTS (EXCLUDING CALVES) OF TEN LEADING CATTLE MARKETS; AVERAGE 1944 TO 1948, BY RANK, 1949[1]

Market	Average 1944 to 1948	1949
icago, Illinois	2,094,716	1,850,491
naha, Nebraska	1,740,920	1,692,314
nsas City, Missouri	1,892,976	1,672,640
ux City, Iowa	1,345,897	1,332,236
uth St. Paul, Minn.	1,099,413	1,171,613
Louis National Stock Yards, Illinois	1,216,207	939,619
nver, Colorado	825,268	837,815
Joseph, Missouri	577,892	619,928
rt Worth, Texas	938,424	577,974
lahoma City, Oklahoma	678,953	564,281
Total of all markets[2]	20,947,914	18,828,446

[1] *Livestock Market News, Statistics and Related Data*, 1949, U. S. Dept. Agri., August, 1950, p. 8.
Ibid., 1947, p. 12.
[2] Includes 66 markets.

TABLE 28

LF RECEIPTS OF TEN LEADING CALF MARKETS; AVERAGE 1944 TO 1948, BY RANK, 1949[1]

Market	Average 1944 to 1948	1949
St. Paul, Minnesota	541,800	544,461
lwaukee, Wisconsin	429,865	419,165
Louis National Stock Yards, Illinois	517,651	387,899
rt Worth, Texas	452,400	244,578
nsas City, Missouri	324,200	220,769
troit, Michigan	266,492	210,084
rsey City, New Jersey	371,556	198,234
uston, Texas	261,634	193,334
icago, Illinois	274,161	170,125
n Antonio, Texas	298,704	168,932
Total in all markets[2]	6,982,583	5,740,611

[1] *Livestock Market News, Statistics and Related Data*, 1949, U. S. Dept. Agri., August, 1950, p. 9.
Ibid., 1948, August, 1949, p. 9.
Ibid., 1946, Sept., 1947, p. 13.
Livestock Meats and Wool Market Statistics and Related Data, 1945, S. Dept. of Agri., 1946, p. 12.
[2] Includes 66 markets.

herds because of undesirable type or breeding from the standpoint of future development. It can be expected, therefore, that the leading calf markets would not coincide with the leading cattle markets. Table 28 shows the ten leading calf markets in the United States.

LEADING FEEDER CATTLE MARKETS

Cattle feeding often involves a two-phase type of operation. Thus the western range area is well adapted to a cow and calf proposition, and because of the abundance of relatively cheap forage, many of the steers are grown out and marketed as year-

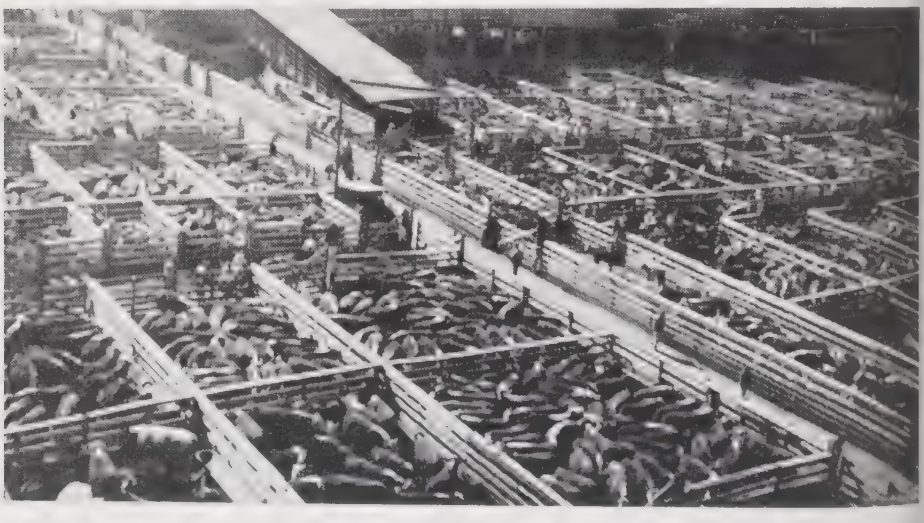


Fig. 179. Portion of the cattle pens of the Kansas City market. Kansas City has long been the greatest feeder cattle market in the United States. (Courtesy, Kansas City Stock Yard Co.)

lings or two-year-olds. On the other hand, the Corn Belt produces a great surplus of grain and is noted as a cattle feeding center. It is but natural that the leading feeder cattle markets should be conveniently located between the range producing area and the Corn Belt feeding area. Table 29 gives the ten leading feeder cattle markets by rank, whereas Table 30 shows the state destination of feeder cattle.

Table 29 shows the central markets upon which most feeder cattle are handled, whereas Table 30 indicates the states which acquire the greatest numbers of market feeder cattle from outside sources for fattening purposes.

In recent years, there has been an increasing tendency to market feeder cattle direct, without passing them through the central market. A considerable and increasing number of western

TABLE 29

FEEDER CATTLE RECEIPTS OF TEN LEADING MARKETS, AVERAGE 1944 TO 1948, BY RANK, 1949[1]

Market	Average 1944 to 1948	1949
ısas City, Missouri	488,850	567,366
ux City, Iowa	379,054	513,859
aha, Nebraska	393,174	448,466
ver, Colorado	331,338	345,883
Antonio, Texas	237,019	236,091
ahoma City, Oklahoma	184,765	220,619
St. Paul, Minnesota	173,734	184,676
Louis area[2]	157,618	154,625
hita, Kansas	159,955	143,909
t Worth, Texas	165,979	95,334
al feeder cattle receipts or ten markets	2,671,486	2,910,828
al feeder cattle received t all United States markets[3]	3,642,733	4,185,674

[1] *Livestock Market News, Statistics and Related Data*, 1947, U. S. Dept. gri., July, 1948, p. 26. *Ibid.*, 1949, p. 17.
[2] Includes St. Louis National Stockyards, Illinois and St. Louis, Mis- i.
[3] Excludes Hawaii.

TABLE 30

EN LEADING STATE-DESTINATIONS OF MARKET FEEDER CATTLE; AVERAGE 1944 TO 1948, BY RANK, 1949[1]
(Not including "Direct" Shipments)

	Average 1944 to 1948	1949
a	637,590	808,382
ois	449,523	520,089
raska	326,657	344,866
sas	330,092	304,798
souri	212,599	281,483
as	187,733	267,820
fornia	209,805	224,934
ahoma	141,638	209,506
rado	184,570	176,477
iana	128,477	136,385
al feeder cattle destined or ten states	2,808,684	3,274,740
al feeder cattle in United States[2]	3,642,733	4,185,674

[1] *Livestock Market News, Statistics and Related Data*, 1947, U. S. Dept. gri., July, 1948, p. 26. *Ibid.*, 1949, p. 17.
[2] Excludes Hawaii. This figure includes market feeder cattle only.

producers also are arranging to have their feeders fed out on contract. Despite these other methods of handling, about four million head of feeder cattle pass through United States central markets each year.

MARKET CLASSES AND GRADES OF CATTLE

The generally accepted market classes and grades of live cattle are summarized in Table 31. The first five divisions and subdivisions include those factors that determine the class of the

TABLE 31

THE MARKET CLASSES AND GRADES OF CATTLE

Cattle or Calves	Use Selection	Sex Classes	Age	Weight Divisions (Wt. Group) (lbs.)	Commonly Used Grades
Cattle	Slaughter Cattle	Steers	Yearlings	Light 750 down; Medium 750-950; Heavy 950-up	Prime, Choice, Good, Commercial, Utility, Cutter Ca
			2-year-old and over	Light 1100 down; Medium 1100-1300; Heavy 1300-up	Prime, Choice, Good, Commercial, Utility, Cutter, Ca
		Heifers	Yearlings	Light 750 down; Medium 750-900; Heavy 900 up	Prime, Choice, Good, Commercial, Utility, Cutter, C
			2-year-old and over	Light 900 down; Medium 900-1050; Heavy 1050 up	Prime, Choice, Good, Commercial, Utility, Cutter, C
		Cows	All ages	All Weights	Choice, Good, Commercial, Utility, Cutter, Canner
		Bulls (choice & good grade bulls often called "beef" or "butcher" bulls, & lower grades bologna bulls)	Yearlings	All Weights	Choice, Good, Commercial, Utility, Cutter, Canner
			2-year-old and over	Light 1300 down; Medium 1300-1500; Heavy 1500 up	Choice, Good, Commercial, Utility, Cutter, Canner
		Stags	All ages	All Weights	Choice, Good, Commercial, Utility, Cutter, Canner
	Stocker & Feeder Cattle	Steers	Yearlings	Heavy, Medium, Light, Mixed	Fancy, Choice, Good, Medium, Common, Inferior
			2-year-old and over	Heavy, Medium, Light, Mixed	Fancy, Choice, Good, Medium, Common, Inferior
		Heifers	Yearlings	Heavy, Medium, Light, Mixed	Fancy, Choice, Good, Medium, Common, Inferior
			2-year-old and over	Heavy, Medium, Light, Mixed	Fancy, Choice, Good, Medium, Common, Inferior
		Cows	All ages	All Weights	Choice, Good. Medium, Common, Inferior
		Bulls	All ages	All Weights	Choice, Good, Medium, Common, Inferior
		Stags	All ages	All Weights	Choice, Good, Medium, Common, Inferior
	Milkers & Springers	Cows (milkers or springers)	All ages	All Weights	None
Calves	Vealers	No Sex Class (Sex characteristics of no importance at this age)	Under 3 months	Light 110 down; Medium 110-180; Heavy 180 up	Prime, Choice, Good, Commercial, Utility, Cull
	Slaughter Calves	Steers, Heifers, Bulls	3 months to 1 year	Light 200 down; Medium 200-300; Heavy 300 up	Prime, Choice, Good, Commercial, Utility, Cull
	Stocker & Feeder Calves	Steers, Heifers, Bulls	Usually 6 mo. to 1 year	Heavy, Medium, Light, Mixed	Fancy, Choice, Good, Medium, Common, Inferior

ıal or the use to which it will be put. The grades indicate how the cattle fulfill the requirements to which they are put.

ors Determining Market Classes of Cattle

The market class of cattle is determined by (1) use selection, sex, (3) age, and (4) weight.

TLE AND CALVES:

All members of the bovine family are designated as "calves" l they are one year of age after which they are known as tle." On the average, about 31 per cent of all slaughter e are calves and 69 per cent cattle.

SELECTION OF CATTLE AND CALVES:

The cattle group is further divided into three use divisions, indicating something of the purpose to which the animals be put. These divisions are: (1) slaughter cattle, (2) stocker feeder cattle, and (3) milkers and springers. Slaughter cattle ıde those which are considered suitable for immediate slaugh- stockers and feeders include those which are to be taken to the country and grown for a time or fattened; and milk- and springers include those cows recently freshened or soon to calve and which are sold for milk purposes.

The calf group is also subdivided into three classes: (1) ers, including milk-fat animals under three months of age h are sold for immediate slaughter; (2) slaughter calves are between the ages of three months and one year, which usually received grain in addition to milk, and which are enough for slaughter; and (3) stocker and feeder calves h are of weaning age and are sold to go back into the coun- for further growing or fattening.

In the selection of stocker and feeder cattle or calves, the age, weight, and grade are of importance. In addition, con- ration should be given to the following factors: (1) constitu- and thrift, (2) natural fleshing, (3) breeding, (4) uniform- (5) absence of horns, and (6) temperament and disposition.

As can be readily understood, the uses to which animals are is not always clear-cut and definite. Thus, when feed is dant and factors are favorable for cattle fattening, feeders outbid packer buyers for some of the animals that would nally go for slaughter purposes. On the other hand, slaugh- s frequently outbid feeders for some of those animals that d normally go the stocker and feeder route.

THE SEX CLASSES:

Cattle are divided into five sex classes: steers, heifers, cows, bulls, and stags. Each of these groups has rather definite and easily distinguishable characteristics that are related to the commercial value of the carcass—especially in the "cattle" group—and which are important in determining the suitability of animals as stockers and feeders. In older cattle, sex is an important factor affecting carcass quality, finish, and confirmation. The definition of each sex class follows:

Steer.—A steer is a male bovine animal that was castrated at an early age, before reaching sexual maturity and before developing the physical characteristics peculiar to bulls.

Heifer.—A heifer is a female bovine animal that has not had a calf or has not reached the stage of advanced pregnancy or has not developed the mature form of a cow.

Cow.—A cow is a female bovine animal that has had one or more calves or that has reached the stage of advanced pregnancy. Barren female bovine animals that have reached maturity and have developed the predominating physical characteristics peculiar to cows also are so classified.

Bull.—A bull is an uncastrated male bovine animal of any age.

Stag.—A stag, as applied to cattle, is a male bovine animal that was castrated after it had developed the physical characteristics of a mature bull.

Calves are merely divided into three sex classes: steers, heifers, or bulls. Because the secondary sex characteristics are not very pronounced in this group, the sex classes are of less importance for slaughter purposes than in older cattle. On the other hand, bull calves are not preferred as feeders because castration involves extra trouble and risk of loss.

AGE GROUPS:

Because the age of cattle does affect certain carcass characteristics, it is logical that age groups should exist in market classifications. The terms used to indicate approximate age ranges for cattle are: vealers, calves, yearlings, two-year-old and older cattle. As previously indicated, vealers are under three months of age,[1] whereas calves are young cattle between the vealer and yearling stage. Yearlings range from twelve to twenty-four months in age, and two-year-olds from twenty-four

[1]Vealers must also be over twenty-one days of age for slaughter. Under age veal calves are called "deacons" or "bob veal."

hirty-six months. Older cattle are usually grouped along with two-year-olds as "two-year-old and over."

IGHT DIVISIONS:

It is common to have three weight divisions: light, medium, heavy. When several weight divisions are included together, y are referred to as "mixed weight." The usual practice is to up animals by rather narrow weight divisions because pur-sers are frequently rather "choosey" about weights, and mar-values often vary quite sharply with variations in weights.

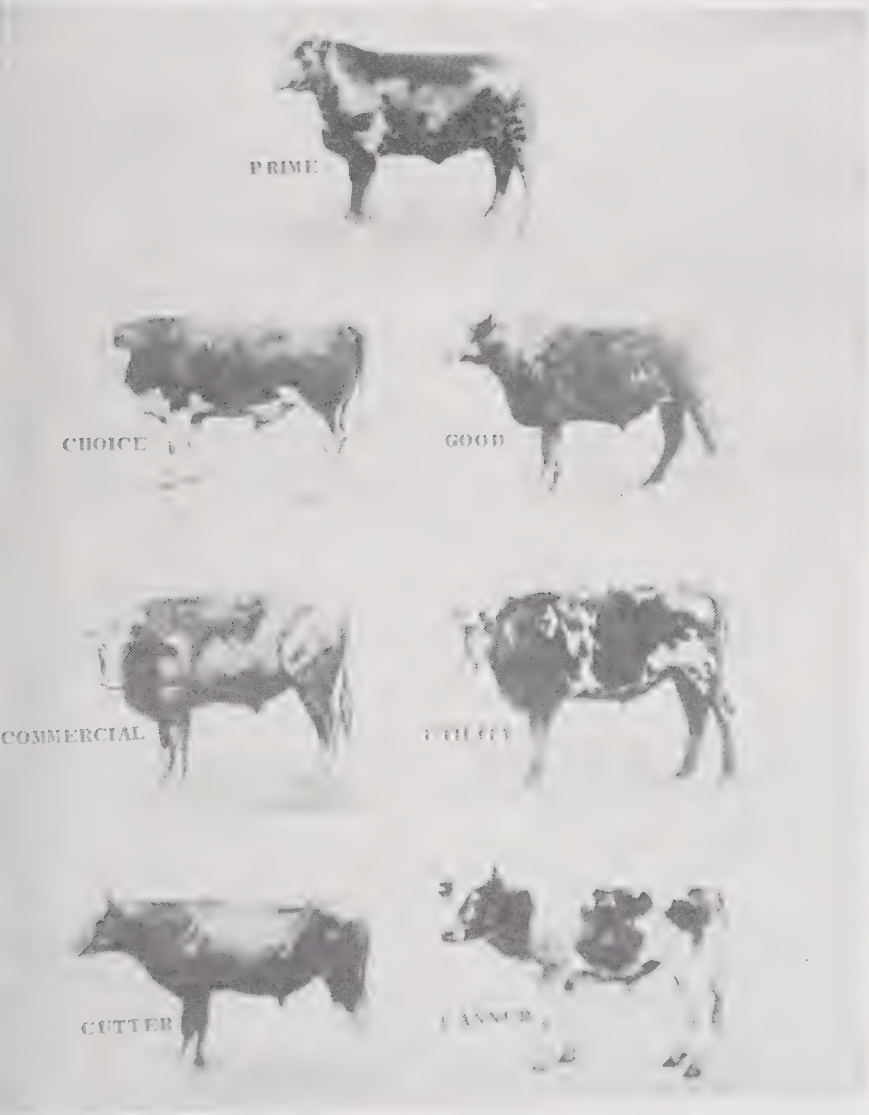


Fig. 180. The market grades of slaughter steers. Names changed to orm to new U.S.D.A. grades, as interpreted by the author. (Courtesy, D.A., Production and Marketing Administration.)

The Market Grades of Cattle

While no official grading of live animals is done by the U. S. Department of Agriculture, market grades do form a basis for uniform reporting of livestock marketing. The grade is the final step in classifying any kind of market livestock. It indicates the relative degree of excellence of an animal or group of animals. The three factors of primary importance in determining cattle grades—conformation, finish, and quality—apply to all classes of market animals. Since they have been discussed in the general chapter on marketing livestock, no repetition will be necessary.

Effective December 30, 1950, the USDA announced changes affecting both the grade names and the specifications of the respective grades for slaughter (live) cattle. These changes were designed to bring the slaughter grades in line with the new speci-



Fig. 181. The market grades of feeder steers. (Courtesy, U.S.D.A. Production and Marketing Administration.)

ions for carcass grades of beef. Table 32 gives a comparison ween the old and the new grades of slaughter cattle. The nges are: (1) The former Prime and Choice grades were com- d into Prime, (2) The former Good grade was changed to ice, (3) The former Medium grade was split up, with the nger cattle in the top half going into the new Good grade the remainder of the group renamed Commercial, and (4) former Common grade was renamed Utility. The two bottom les, Cutter and Canner, remained unchanged.

In addition to standardizing grade names and specifications ive cattle and carcass beef, thus showing how one reflects the r, the new grade structure is in line with current production tices and consumer preferences for smaller cuts of beef with e lean and less fat.

TABLE 32

COMPARISON BETWEEN PRESENT AND FORMER U.S.D.A. GRADES OF SLAUGHTER (LIVE) CATTLE

Present U.S.D.A. Grades Slaughter Cattle (Since Dec. 30, 1950)	Former U.S.D.A. Grades Slaughter Cattle (Prior to Dec. 30, 1950)
Prime	Prime
	Choice
Choice	Good
Good	Medium
Commercial	
Utility	Common
Cutter	Cutter
Canner	Canner

The number of grades of cattle vary somewhat between the ses, chiefly because certain groups of animals present a wider ge of variations in conformation, finish, and quality than do r groups. Slaughter steers and heifers are divided into seven les: Prime, Choice, Good, Commercial, Utility, Cutter, and ner. However, only six grades apply to slaughter cows, bulls, stags—the grade "Prime" being deleted chiefly because of ient conformation, finish, and quality in these classes. Fur-, as in carcasses, bulls and stags on foot are always desig- d as "slaughter bulls" and "slaughter stags," since meat ob- ed from these respective classes is never interchanged (1)

with each other, or, (2) with meat carrying the same grade name from steers, heifers, and cows.

The terms Cutter or Canner are applied to the two lowest grades of slaughter cattle. Cutter cattle are so poor in form and lacking in muscle and fat covering that only such wholesale cuts as the loin and round are cut out and sold over the block. The balance of the carcass is boned out and used in sausage and canned-meat products. Canners are almost entirely processed as ground and canned meats.

Effective March 10, 1951, revisions were made in the top five grades of slaughter (live) vealers and calves, with the Cull grade remaining unchanged. This placed vealers and calves in line with the new cattle grades. Thus the present grades of vealers and calves are: Prime, Choice, Good, Commercial, Utility and Cull.

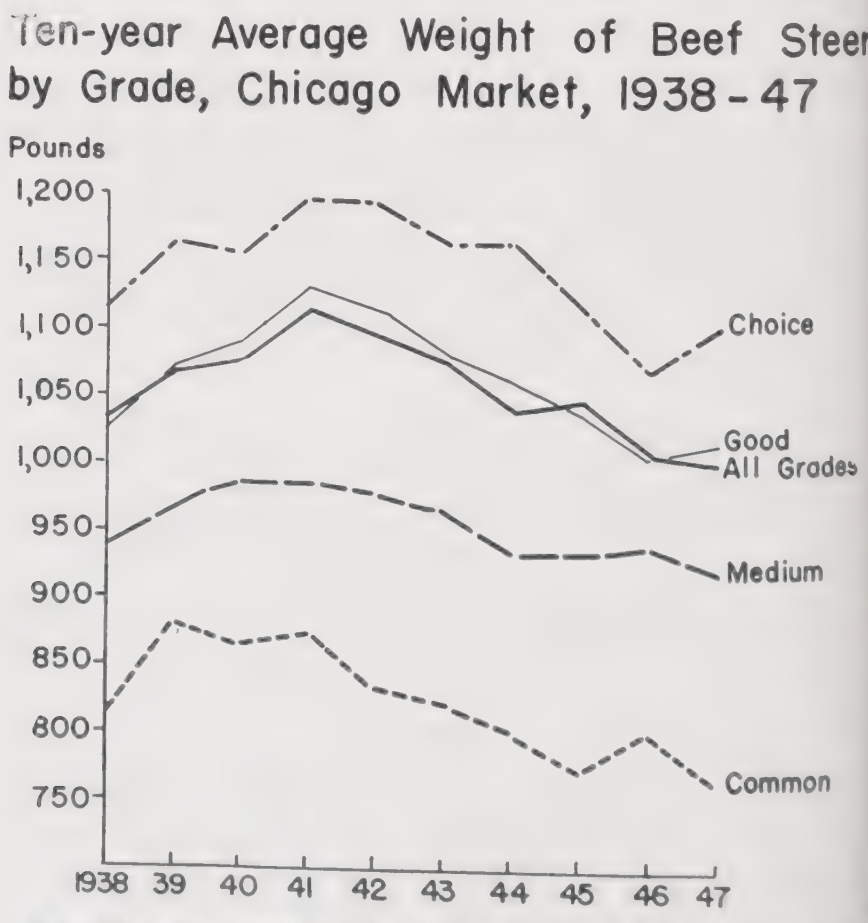


Fig. 182. This shows that the higher grades of fat cattle usually carry more weight, and the lower grades are lighter and usually underfinished. Note that the old grades (which existed prior to Dec. 30, 1950) are employed. Similar data for the new grades will become available eventually. (Data from Livestock Market News, U.S.D.A., July, 1948, p. 61.).

Stocker and feeder steers and heifers, and stocker and feeder
s are divided into six grades: Fancy, Choice, Good, Medium,
mon, and Inferior. The highest grade is called "Fancy" or
cy selected" instead of "Prime," and the term "Inferior" is
for the lowest grade. The grade "Prime" is not applied to
er and feeder cattle or calves because it signifies a high de-

n-year Average Price Per Cwt of Beef eers by Grade, Chicago Market, 1938-47

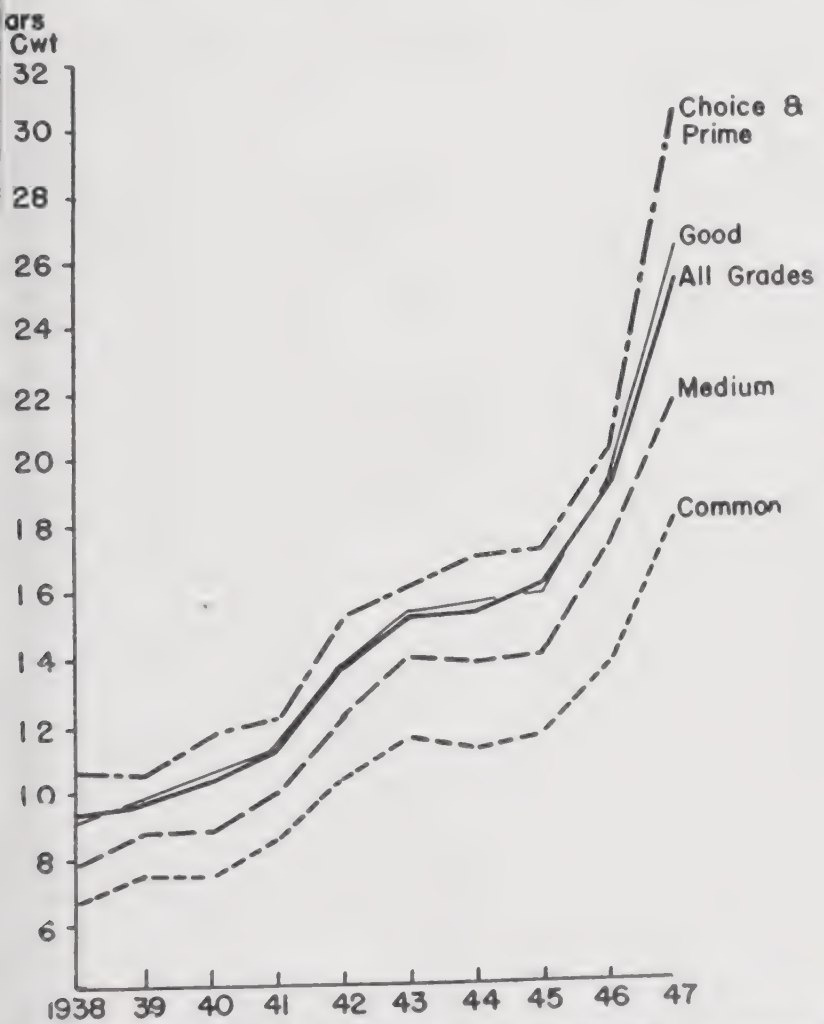


Fig. 183. This shows that there is a rather uniform difference in the
ng price of the different grades of cattle, with a slightly greater spread
een the lower grades. Note that the old grades (which existed prior to
mber 30, 1950) are employed. Similar data for the new grades will be
available eventually. (Data from Livestock Market News, U.S.D.A.,
1948, p. 61.)

gree of finish that such animals do not possess. The term "Inferior" is used in grading stocker and feeder cattle in order to denote poor breeding and conformation as well as poor condition. Only five grades apply to stocker and feeder cows, bulls, and stags —the grade Fancy being deleted because of insufficient quality.

High grade feeder animals normally produce high grade slaughter animals, but no amount of care and management can transform low grade feeder animals into high grade slaughter animals. On the other hand, with proper finish, many feeders regularly plan to up the projected slaughter grade of lower quality feeder cattle by at least one grade.

As would be expected, the higher grades of fat cattle usually carry more weight, and the lower grades are lighter and usually underfinished. Figure 182 shows the relationship of the weight of beef steers to the grade.

Because the production of the better grades of cattle usually involves more expenditure in the breeding operations (because of the need for superior animals) and feeding to a higher degree of finish, there must be a spread in market grades in order to make the production of the top grades profitable. Figure 183 shows the ten-year average price per hundredweight of beef steers, by grades, on the Chicago market from 1938 to 1947.

OTHER CATTLE MARKET TERMS AND FACTORS

In addition to the more or less general terminology used in cattle dealing and reporting, the following terms and factors are significant:

Native and Western Cattle

"Native cattle" are those coming from the farms of the Corn Belt, East, and South; whereas "western cattle" are the branded cattle coming from the western ranges. Not so long ago, western cattle lacked the breeding and quality of native cattle. But this condition no longer prevails. Today many of the champion steers at the major shows throughout the country come from range herds, and, in general, range shipments possess far more uniformity than native cattle.

Grassers and Fed Cattle

The term "grassers" designates animals that have not been grain fed and which come direct from the pasture or range. "Fed cattle" are those that have been fed grain. "Short-fed" cattle are those which have been grain fed for 60 to 120 days, whereas "long-fed" cattle have been grain fed for more than 120 days.

y Beef

The term "baby beef" is frequently applied to Prime or ice animals (either steers or heifers) from twelve to eighteen ths of age and weighing 700 to 1,200 pounds on foot. For most part these animals have never been allowed to lose r milk fat.

cher Stock

On many markets the term "butcher stock" is used to desig- heifers, cows, bulls, and stags marketed for slaughter and able to be sold in the carcass as block beef. These carcasses largely sold to city and country retail dealers or butchers; ce the term "butcher stock" is applied to this class of market le.

ogna Bulls

Bologna bulls are bulls that are muscular but not sufficiently for block beef purposes. The meat from such carcasses is ally used in the manufacture of bologna sausage.

CKER SLAUGHTERING AND DRESSING BEEF CATTLE

Table 33 shows the proportion of cattle and calves slaugh- d in federally inspected plants. The total figure refers to the nber dressed in all establishments and on farms. Although n slaughter procedure may differ somewhat, the ultimate ective is always the same. Because of the greater total num- s of cattle involved in this system of handling, only packer ghtering and dressing will be discussed.

Cattle intended for slaughter purposes are bought primarily he basis of projected quality of carcass and dressing percent-

TABLE 33

PROPORTION OF CATTLE AND CALVES SLAUGHTERED IN FEDERALLY INSPECTED PLANTS, 1945 to 1949[1]

Year	Cattle		Calves	
	Slaughtered under federal inspection	Total	Slaughtered under federal inspection	Total
	(1,000 head)	(1,000 head)	(1,000 head)	(1,000 head)
5	14,538	21,691	7,020	13,645
6	11,413	19,824	5,830	12,168
7	15,524	22,393	7,933	13,695
8	12,994	19,186	6,907	12,328
9	13,222	18,789	6,449	11,345

[1] *Livestock Market News, Statistics and Related Data*, 1949, U. S. Dept. Agri., August, 1950, p. 23.

age. Upon reaching the packing house, cattle rapidly pass through the operations of killing and dressing. Unlike most manufacturing, meat packing is primarily a disassembly process wherein the manufacturing operation starts with a complete unit that is progressively broken down into its component parts. The various parts then are subjected to divergent processing operations. Because of their size and other physical characteristics, cattle cannot be processed with the endless chain method of dressing that is used in the dressing of hogs, calves, and sheep.

Steps in Slaughtering and Dressing Cattle

The slaughtering and dressing procedure differs somewhat between plants, but in general the process consists of the following steps:

1. **Stunning.**—Cattle are driven into knocking pens and are stunned by means of a sharp blow on the forehead from a light sledge hammer. The side of the knocking pen is then lifted, allowing the stunned animal to roll out on the killing floor.

2. **Shackling, hoisting, sticking, and bleeding.**—The animal is next shackled, hoisted by the hind legs, stuck, and bled. The head is then skinned and removed.

3. **Lowering to floor and partial skinning.**—The carcass is next lowered to the floor; the shanks are skinned and removed at the knees and hocks; the hide is opened along the median line on the belly and is removed from the belly and sides; and the breast and aitch (rump) bones are split by sawing.

4. **Raising to "half-hoist" position and further skinning.**—Beef hooks are inserted on the gam cord and the carcass is partially raised to a position known as "half-hoist." In this position the skinning of the shanks is completed and the round and rump are skinned out.

5. **Hoisting carcass to overhead track, completing skinning, removing viscera.**—All internal organs are removed except the kidneys. If the plant is under federal inspection, the carcass and viscera are examined at this stage in the slaughtering process.

6. **Splitting carcass and removing tail.**—The carcass is then split through the center of the backbone and the tail is removed.

7. **Washing and drying.**—The split carcass or sides are washed with warm water under pressure.

8. **Shrouding.**—The better carcasses are shrouded tightly with cloth so that they may have a smoother appearance following chilling.

9. **Sending to coolers.**—Following slaughtering, the sides ent to the coolers where they are kept at a temperature of t 34° F. for a minimum period of twenty-four hours before ng.

Slaughtering of Veal Calves Differs

Because of their smaller size, calves may be dressed by the less-chain" method. A wheel hoist is used in lifting the kled calves to the rail. They are then stuck, bled, dressed, washed. Because of the high moisture content of veal, the is usually left on for the purpose of reducing evaporation. also produces a more desirable carcass color. When the hide ft on, it is thoroughly washed before the carcass is sent to ooler.

ıer Slaughter

Meat for the Jewish trade must come from animals slaughd according to the rules of Shehitah (the ancient dietary s). Although we usually think in terms of beef when Kosheris mentioned, lamb, mutton, veal, and even poultry are sed in this manner.

In Kosher slaughter the animal is hoisted without stunning is cut across the throat with a special type of knife. The ng is performed by a rabbi of the Jewish church or a specially ıed representative. This method of killing causes more int death and a rapid, free flow of blood from the animal. The i or schlachter also makes an inspection of the lungs while sing. If the carcass is acceptable, it is marked on the brisket a cross inside a circle. The mark also gives the date of ghter and the name of the inspector.

Kosher meat must be sold by the retailer within seventy-two rs after the time it is killed, or it must be washed and reined by a representative of the synagogue every subsequent nty-two hours. A maximum total holding period of 216 hours llowed following slaughter. For this reason, rapid handling Kosher beef following slaughter is imperative. Because most ıe four million Jews in the United States are in the eastern es, large numbers of live cattle are shipped from the large kets farther west to be slaughtered in or near the eastern uming areas.

Dressing Percentage

Dressing percentage may be defined as the percentage yield hilled carcass in relation to the weight of the animal on foot.

For example, a steer which weighed 1,200 pounds on foot an yielded a carcass weighing 720 pounds may be said to have dressing percentage of 60. The offal—so-called because formerl (with the exception of the hide, tallow, and tongue) the offa (waste) was thrown away—consists of the blood, head, shanks tail, hide, viscera, and loose fat.

A high carcass yield is desirable because the carcass is muc more valuable than the by-products. Although the packers hav done a marvelous job in utilizing by-products, about 88 per cen of the income from cattle is derived from the sale of the carcas and only 12 per cent from the by-products. Thus the estimate dressing percentage of slaughter cattle is justifiably a majo factor in determining the price or value of the live animal.

The chief factors determining the dressing percentage o cattle are: (1) the amount of fill, (2) the finish or degree o fatness, (3) the general quality and refinement (refinement o head, bone, hide, etc.), and (4) the size of udder. The bette grades of steers have the highest dressing percentage, with thi canner cows showing the lowest yield. The following ranges i dressing percentages may be expected for different grades o cattle:[1]

Grades of cattle	Dressing percentage	
	Steers and heifers	Cows
Prime	62 - 67	
Choice	60 - 64	
Good	58 - 60	52 - 5
Medium	52 - 58	47 - 5
Cutter and canner	40 - 52	40 - 4

The highest dressing percentage on record was a yield o 76¾ per cent made by a spayed Angus heifer at the Smithfiel Fat Stock Show in England. It is estimated that market cattle i the United States dress about 54 per cent and veal calves abou 57 per cent. The higher dressing percentage for veal calves is du to the fact that they are dressed with the hide on.

The average live weights of cattle and calves dressed b commercial meat packing plants, and their percentage yields o meats, for the ten-year period 1938 to 1947 were as follows

[1]Note that the old grades (which existed prior to Dec., 1950) were e ployed. Similar data for the new grades will become available eventuall

[2]*Livestock Market News, Statistics, and Related Data*, U. S. Dept Agri., 1948, pp. 78 and 79.

	Average live weight (in pounds)	Average yield in meats (in pounds)	Dressing percentage
le	941.6	504.1	53.5
es	202.2	112.4	55.6

NG BEEF

Except for veal, fresh beef is not at optimum tenderness ediately after slaughter. It must undergo an aging or ripen- process before it really becomes tender. This process consists ie dissolution of the connective tissue (collagen) by the ac- of enzymes. Beef should be aged from two to six weeks at peratures ranging from 34° to 38° F., but only the better es can be aged for the longer periods. Beef must have a fat



Fig. 184. Aging beef in a cooler. Beef should be aged from 2 to 6 weeks mperatures ranging from 34° to 38° F. (Courtesy, American Meat tute.)

covering to protect the meat from bacterial action by sealing from the air. With well-finished beef, some trimming is necessar anyway and the removal of the mold does not constitute a additional loss. The aging process may be hastened by the u of ultra-violet lights in high temperature coolers with controlle humidity.

DISPOSITION OF THE BEEF CARCASS

Beef carcasses are of two types, namely those suitable f (1) block beef and (2) processed meats.

1. **Block beef.**—Block beef refers to beef that is suitable f sale over the block. Such beef is purchased by the retailer sides, quarters, or the wholesale cuts. Block beef may enter re ular channels of trade either as "fresh chilled" or "fresh frozen Fresh chilled beef is chilled at temperatures ranging from 3 to 38° F. for a minimum of twenty-four hours before moving o to the retail trade, or it may be held longer if aging is desire Frozen beef is subjected to temperatures of 0° F. or below a is frozen solid, in which form it can be kept for a period several months. United States consumers prefer "fresh chille beef. It is estimated that 97 per cent of the block beef is handled. On the other hand, the bulk of the export beef is froz

2. **Processed meats.**—Beef that is not suitable for sale o the block is boned out and disposed of as boneless cuts, is canne is made into sausage, or is cured by drying and smoking. It estimated that about one-fifth of all slaughter cattle are dispos of as processed meats.

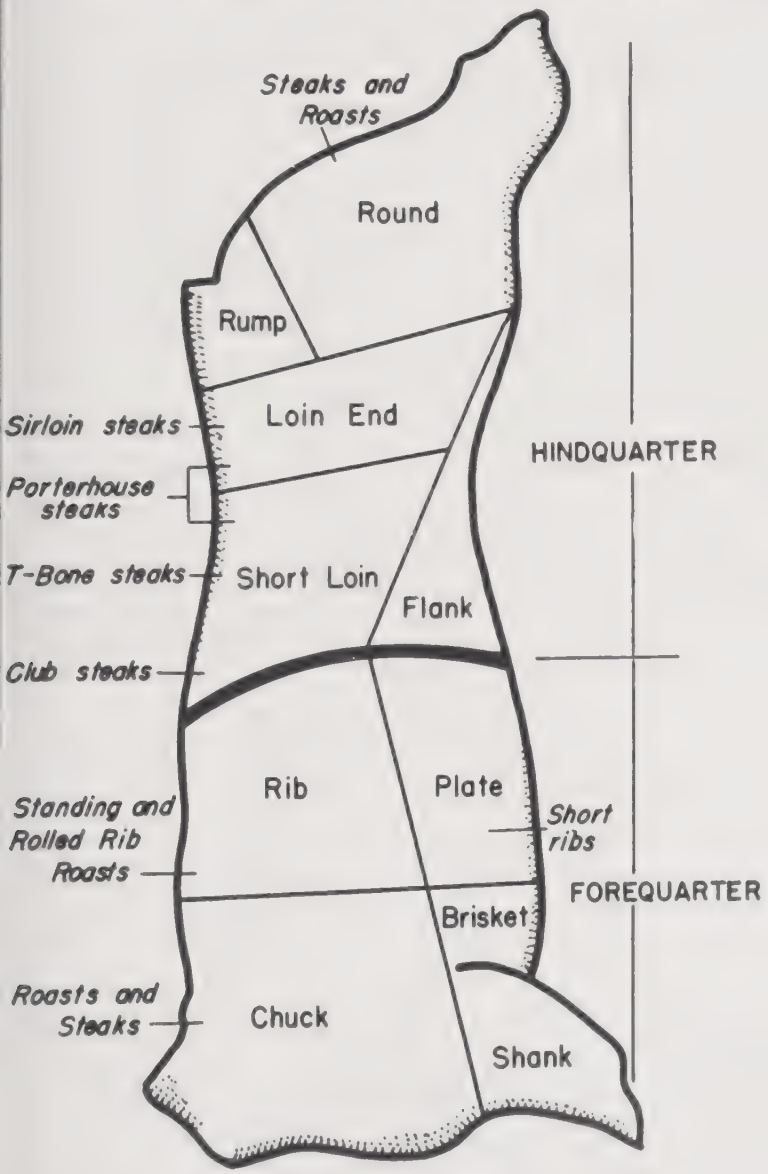
THE BEEF CARCASS AND ITS CUTS

The methods of cutting beef are more varied than are fou in the cutting of veal, lamb, or pork. Each area has its traditio cuts of beef. In the Midwest and West, most cutting is accordi to the Chicago style in which the wholesale cut known as rib has the seven last ribs on the front quarter and has five r on the chuck. On the other hand, the eastern seaboard sta adhere mostly to the New York style in which the rib cut inclu eight ribs, and the short chuck, four ribs.

In quartering beef, all thirteen ribs are left on the fo quarter for the Brooklyn and Philadelphia markets; where three ribs are included on the hindquarter for the Boston mark Most other markets cut one rib on the hindquarter. Natura the number of ribs left on the hindquarter affects the percenta weight of fores and hinds. Thus, a three-rib hindquarter re

about 50 per cent of the side; one-rib hinds represent about cent of the side; whereas a hind without any ribs repre- only 46 to 47 per cent of the side.

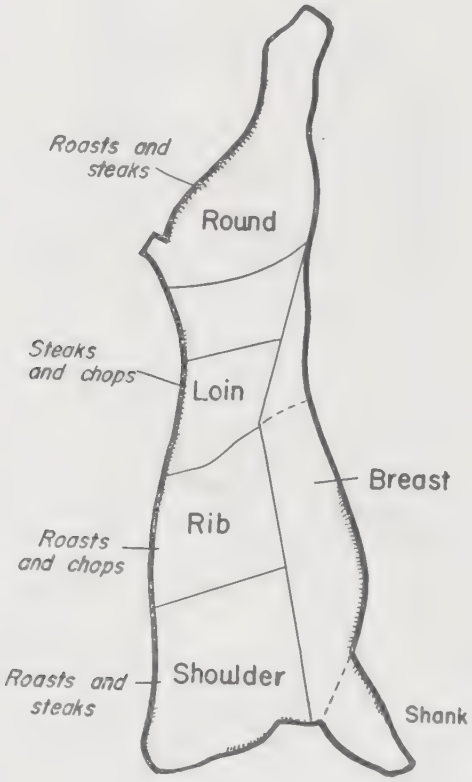
lthough considerable beef is shipped to retail shops as and quarters, most retailers like to handle a considerable



g. 185. Wholesale cuts of beef, and some of the common retail cuts, ut Chicago style. (Drawing by R. F. Johnson.)

quantity of wholesale cuts because of the flexibility afforded. I steaks are in greater demand, therefore, steak-yielding cuts ma be obtained without getting an oversupply of cuts better adapte for other purposes (roasts, stews, etc.).

When cut Chicago style, the forequarter yields five wholesal cuts: chuck, rib, plate, brisket, and shank. The hindquarter i divided into five wholesale cuts: round, rump, loin end, short loi and flank. Figure 185 shows the wholesale cuts of a side of bee and some of the common retail cuts when cut according to th Chicago style.



Veal

Fig. 186. Wholesale cuts of veal and some of the common retail cuts. (Drawing by R. F. Johnson.)

THE VEAL CARCASS AND ITS CUTS

Because veal has very little protective fat covering and high in moisture, it does not lend itself to aging or ripening. is therefore necessary that veal be moved into retail channe fairly rapidly.

The size of the veal carcass will determine the method of ting. The larger carcasses (calf rather than veal carcasses) generally halved and then quartered much like beef car-ses, whereas practically all of the younger veal carcasses are into fore and hind saddles.

The fore saddle consists of that part of the carcass anterior the twelfth rib or the two unsplit forequarters. The hind dle consists of the two unsplit hindquarters posterior to the lfth rib.

When the veal carcass is further divided, the common whole-cuts from the hindquarter are the leg and loin; and from forequarter, the rib, shoulder, breast and shank. Figure 186 ws the common wholesale cuts of veal and some of the com-n retail cuts. The veal carcass is generally sold with the liver sweetbread attached.

Reference

Added chapters on Beef Cattle Management; Buildings and ipment For Beef Cattle; Beef Cattle Health, Disease Preven-, and Parasite Control; and Selecting, Fitting, and Showing f Cattle are included in the following book by the same hor and the same publisher as *Animal Science:*

Beef Cattle Husbandry

CHAPTER XVI

HISTORY AND DEVELOPMENT OF THE SHEEP AND GOAT INDUSTRY[1]

Sheep and goats were first domesticated in the New Stone Age. The first Egyptian portrayal of sheep appears on one of the earliest sculptures known, dating back to 4000 B. C. Some subsequent sculptures showed one of the early uses of sheep—that of being driven across the freshly sown fields in the Nile Valley to tread in the grain. Other historical records show that sheep provided primitive pastoral peoples with meat, wool, tallow, skins, and milk.

Sheep belong to the genus *Ovis*, and goats and their wild relatives make up the genus *Capra*. These two genera of the family Bovidae, *Ovis* and *Capra*, are closely related, so closely related, in fact, that a naturalist never speaks lightly of "separating the sheep from the goats." Goats may be distinguished from sheep, however, by the presence of a beard, by the absence of the foot glands (which sheep have), by the strong smell of the bucks, and by differences in horns and skeleton. Goats also are more intelligent, independent, and possess greater ability to fight and fend for themselves.

ORIGIN AND DOMESTICATION OF SHEEP

There is more confusion and disagreement about the ancestry and classification of sheep than with any other animal. This difficulty arises from the bewildering number of breeds and the marked changes produced by domestication. There are more than two hundred distinct breeds of sheep scattered throughout the world. Although differing widely in body form and wool character, domestic sheep of all breeds are universally timid and defenseless and the least intelligent and the least teachable of all the domestic four-footed animals. These traits are plainly

[1]Many helpful suggestions relative to Chapters XVI through XXV were made by the following competent sheep specialists: Dr. J. C. Miller, Head, Department of Animal Husbandry, Agricultural and Mechanical College of Texas, College Station, Texas; Mr. V. O. McWhorter, sheep rancher and Vice-President, Washington Wool Growers' Association, Yakima, Washington; and Dr. Claire E. Terrill, Western Sheep Breeding Laboratory, U.S.D.A., Dubois, Idaho.

result of selection by man and are connected with the herding sheep in large bands where independence of behavior is a advantage. As a result, domestic sheep have become complete- dependent on man. Unlike other farm animals, they are unable return to a wild life, which we refer to as becoming feral.



Fig. 187. Man has herded sheep and woven wool fibers since the Stone . Sheep have played an important part in world history. (A copper en- ving from a 17th century edition of Vergil's "Bucolica." Photo obtained ugh the courtesy of The Wool Bureau, Inc.)

ough this dependence is a logical final result of domestication, oes appear that the evolution of the sheep in this direction have gone too far, for they are pitifully helpless in emergen-

.

It is certain that domestic sheep came from the wild sheep Europe and Asia. The confusion and disagreement is over the nber of species and the identity of the wild stocks mixed up heir ancestry. One of the chief difficulties in the way of

tracing the ancestry of our domestic sheep lies in the fact that most of them are long tailed, whereas all of the wild species from whence they came are short tailed. It appears, however, that lengthening of the tail is a characteristic which appeared with domestication.

Domestic sheep are thought to descend mainly from two wild stocks: (1) the moufflons *(Ovis musimon* and *Ovis orientalis),* and (2) the Asiatic urial *(Ovis vignei).* There is, however, considerable evidence to indicate that the wild big-horned sheep of Asia may be at least partial progenitors of the fat-rumped sheep of central Asia. Perhaps, too, some modern breeds trace back to other wild stocks than those herein indicated.

The Moufflon

There are two wild stocks of the moufflon, the Asiatic moufflon *(O. orientalis),* a wild sheep still found in Asia Minor and the Caucasus, and the European moufflon *(O. musimon),* which is



Fig. 188. The European Moufflon (*Ovis musimon*), one of the ancestors of domestic sheep. Like all the wild species from which sheep descended, the Moufflon is short tailed. It appears, therefore, that lengthening of the tail is a characteristic which appeared with domestication. (Courtesy, New York Zoological Society.)

ative to Europe and still found in Sardinia and Corsica. These vo relatives are closely allied, but the Asiatic moufflon is redder nd has somewhat different twist to the horns. Both of the oufflon stocks are considered as ancestors of domestic sheep.

Even today relatively unimproved moufflon-like short-tailed omestic sheep exist in different sections of northern Europe. he least modified of these primitive types are the semi-feral ce of sheep on the uninhabited island of Soay, northwest of cotland. The only essential difference between the moufflon and e feral Soay sheep is the shorter wool of the latter. The island Soay is visited once or twice each year by the residents of St. ilda who hunt down the Soay sheep with dogs and shear them.

he Asiatic Urial

The Asiatic urial *(O. vignei)*, which is a smaller race of neep than the moufflon, is native to the grassy open plains of entral Asia. It lives in large flocks and is much less a mountain nimal than the moufflon. Most of our familiar breeds of sheep re thought to be descendants of this wild stock. For example,



Fig. 189. A wild sheep (*Ovis vignei*), native to the province of Punjab northern India. This is a member of the Asiatic urial, the smaller of the o wild ancestors of domestic sheep. Most of our familiar United States eeds of sheep are thought to have descended chiefly, if not entirely, from e Asiatic urial. (Courtesy, New York Zoological Society.)

the Merino seems to have originated in Asia Minor about the eighth century B. C., and to have been spread by the Phoenicians into North Africa and Spain. Likewise, the fat-tailed sheep in western Asia and Africa, the long-tailed African and Arabian breeds, and perhaps the fat-rumped sheep of central Asia are descendants of the Asiatic urial.

ORIGIN AND DOMESTICATION OF GOATS

The ancestry of the goat is far less confused than is that of the sheep, but a report on the wild relatives of this genus will not be given here. Suffice it to say that goats have not produced nearly so many breeds, nor, except for some of the milk-producing types, such extremely modified breeds. Unlike sheep, goats easily return to a wild state if given the opportunity. In fact, only the domestic cat can equal the goat in returning promptly and successfully to the independent life of a wild creature.

Like sheep, goats were probably among the first animals to be domesticated. Goat-like remains are found in the Swiss Lake Dwellings of the New Stone Age, and the goat was well known in Biblical days.

POSITION OF THE SHEEP IN THE ZOOLOGICAL SCHEME

The following outline shows the basic position of the domesticated sheep in the zoological scheme:

Kingdom *Animalia:* Animals collectively; the Animal Kingdom.
Phylum *Chordata:* One of approximately twenty-one phyla of the animal kingdom.
Class *Mammalia:* Mammals or warm-blooded, hairy animals that produce their young alive and suckle them for a variable period on a secretion from the mammary glands.
Order *Artiodactyla:* Even-toed, hoofed mammals.
Family *Bovidae:* Ruminants having polycotyledonary placenta; hollow, non-deciduous, unbranched horns; and nearly universal presence of a gall bladder.
Genus *Ovis:* The genus consisting of the domestic sheep and the majority of wild sheep. The horns form a lateral spiral.
Species *Ovis aries:* Domesticated sheep.

OOL A PRECIOUS FIBER THROUGH THE AGES

Wool was first spun and made into cloth many years before e beginning of recorded history. According to historians, fab-cs of wool have been discovered in the ruins of the Swiss lake llages, which were inhabited during the Neanderthal Age, tween 10,000 and 20,000 years ago. Moreover, wool was used



Fig. 190. Ancient Babylonian loom in operation. Wool was first used as clothing material by the Babylonians beginning about 4000 B. C. (Courtesy, The Bettmann Archive.)

a clothing material by the Babylonians about 4000 B. C., and ieep are pictured on the earliest Egyptian monuments, which ate some time between 5000 and 4000 B. C.

Sheep, therefore, may be considered as one of man's first elpmates, and the weaving and felting of wool were among the rst arts to be developed. In addition to being one of the very rst animals to be domesticated, sheep have also been one of an's most valuable beasts. Besides providing the wool for cloth, is reasonable to surmise that sheep gave primitive skins for is raiment and shelter, and meat and milk for food.

The ancient Egyptians, Babylonians, Greeks and Hebrews did hand spinning and weaving in the home. The wool industry, like most others, first developed as a household craft, rather than as a primitive factory system.

Sheep raising was known as the earliest pastoral industry, and reference is frequently made to it in Old Testament literature. For example, we are told that Abraham, the patriarch of

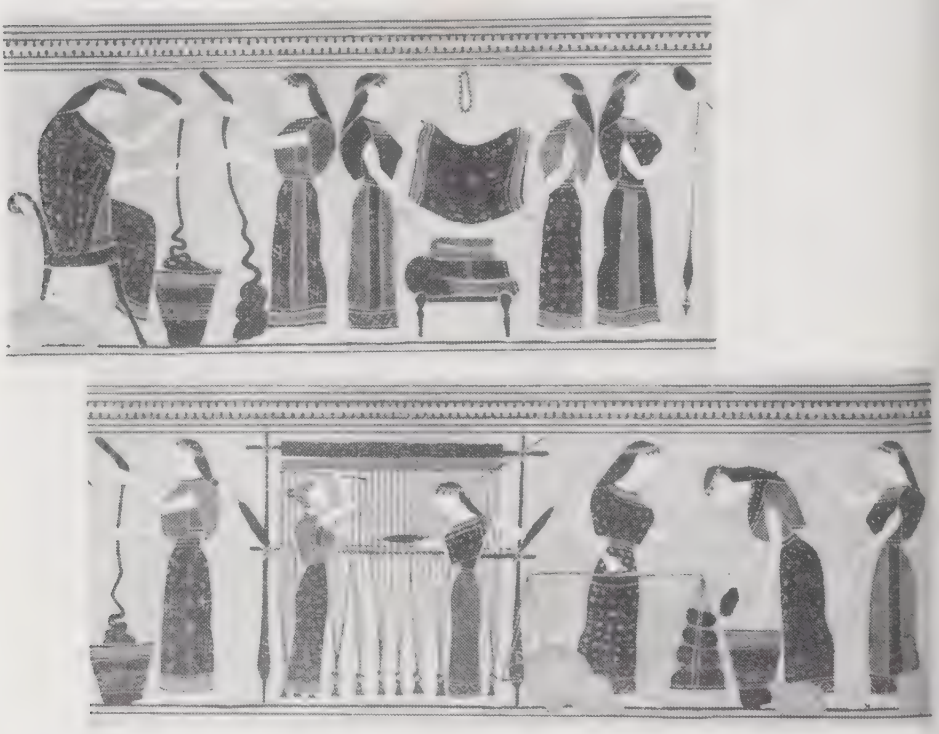


Fig. 191. Ancient Egyptian spinning and weaving. As a household craft, the wool industry had its simple beginning among the Egyptians some time between 5000 and 4000 B. C. (Courtesy, The Metropolitan Museum of Art.)

the Old Testament, thrived and prospered through his great flocks and herds. Subjects of the King of Israel were taxed according to the number of their rams. The Bible also refers to Eve's son, Abel, as a "keeper of sheep"; and it was shepherds watching over their flocks by night who first saw the star over Bethlehem. Sheep raising was recognized as an early agricultural pursuit, and the early herds and flocks served as a medium of exchange.

Sheep were treated with marked respect in Greece. Individual names were given to them and shepherds would proudly call out their favorites. To protect their fleeces from inclement

eather, skins were spread over the animals, while the keeper f the flock had to content himself with a loin cloth.

When Rome was in her glory, her wealthy and refined citi- ens boasted of their achievement in producing the finest quality ool in the world. Sheep were given extraordinary care, and ney were even blanketed so that a luster and gloss might be nparted to the wool. At frequent intervals, the fleece was parted, ombed, and moistened with the rarest oils, oftentimes with ine. Surplus stock was usually killed at two years of age, for ne Romans believed that the fleece was in its best condition t that period. The distinctive toga, a loose outer garment which as worn by officials of ancient Rome when appearing in public time of peace, was made from woolen fabrics.

It can hardly be said, therefore, that domestic sheep are ndigenous to any one country, for they appear to have been ultivated by the earliest peoples in history, and they have radually spread over the entire face of the globe with the exten- on of civilization itself. It is also interesting to note that the fforts of flockmasters have been devoted for centuries to the earch for methods of improving the quality and increasing the uantity of wool produced.

HEEP RAISING IN SPAIN

At a very early date, Spain developed the Merino, a type of neep that produced wool of unusually fine fiber, suitable for naking such fine, soft fabrics as broadcloth.

Before the year 1000, both Spain and England attached reat importance to their flocks; and by the year 1500, they ere recognized as the two greatest sheep-producing countries f the world. Although the Spanish wools were much finer, for everal hundred years Spain and England were regarded as com- etitors on the great wool markets of Flanders.

In Spain, the powerful nobility and clergy engaged in the ucrative sheep industry. In an attempt to produce the finest taple possible, the early Spanish flockmasters drove their sheep rom southern to northern pastures in the spring and returned hem in the fall. In this manner, it was possible to secure the nost favorable grazing and climatic conditions for the flock. The arly laws of the kingdom stipulated that the owners of large ocks should be allowed a path ninety paces wide through all nclosed lands. In the migration process, any animal that failed o keep with the band was left by the wayside. Presumably,

this accounts for the flocking or gregarious instinct of the Merino sheep as well as their hardiness. With the repeal of the migration laws and consequent prohibition of seasonal migration, the Spanish shepherd blanketed his sheep through the colder months —his object being that of keeping an equitable temperature, thus producing a more-uniform and higher-quality product.

It is also interesting to note that Spain long held a monopoly on the Merino sheep. It was a criminal offense punishable by death for anyone to send a sheep of this breed out of the country without the King's permission. This monopoly held until early in the nineteenth century when Spain was invaded by Napoleon who overthrew the government. In this conquest, a large number of Merino sheep were seized and shipped to other countries where they added new chapters to the history of sheep raising.

Spain never regained her high position in world sheep production following Napoleon's invasion, but, even today, sheep are the most numerous livestock of the country—exceeding cattle, horses, goats, and pigs in the aggregate. It is interesting to note, however, that coarse-wooled sheep now predominate in Spain, there being three animals of this type to every one Merino.

SHEEP RAISING IN ENGLAND

During the Middle Ages (500 to 1500) in England, sheep were the sheet anchor of farming. Their chief product was not meat, milk, nor hides, but wool. Unlike the flocks in Spain, those in England were small; the sheep were not in the hands of a very few powerful owners as they were in Spain, and they were not compelled to travel across the country. The great problem of the English sheep farmer, therefore, was to procure sheep that were adapted to his particular locality. This largely accounts for the development of the many types and breeds in that country. The cold winters, scarcity of winter feed, and the presence of scab and rot made the early sheep raising of England a risky venture. The shepherd's position was highly respected, and lame shepherds were in great demands because a lame man was not so likely to overdrive his sheep.

None of the wools from the English breeds was as fine as that of the Merino. Nevertheless, there was a ready market for the English wools because they were more suitable for a variety of uses than those from Spain.

VENTS GIVING NEW IMPETUS O SHEEP RAISING IN ENGLAND

The great plague, or Black Death of 1348 to 1349, served as great impetus to the sheep industry of England. Laborers were duced by the plague and wages rose, forcing the landlords to rn their holdings into pasture. Because of the favorable price r wool and the fact that large numbers of sheep could be rded together with little labor involved, increased attention as given to the sheep industry.

During the reign of Edward III (1327 to 1377), a grant of ecial protection was made in favor of all Flemish weavers, vers, and pullers who would settle in England to follow their ade. Through this grant, England secured artisans skilled in e then most improved methods of cloth making. Later, in the ign of Elizabeth (1557 to 1603), wool was the chief source of e wealth of traders and of the revenues of the crown. It even ntrolled the foreign policy of England.

During the sixteenth century, some changes in agriculture curred, even though very slowly. Iron was used more widely implements, but seeded grasses and roots were still unknown nd ewes were still milked. Despite their low quality, in compari-n with present standards, sheep were considered to be the ost profitable of all English livestock.

The coming of field cultivation of clover and seeded grasses, metime after 1600, and of roots somewhat later, gave new mpetus to all agriculture, including the sheep industry. Winter eed was now assured, and more and better sheep could be aintained.

AKEWELL'S IMPROVEMENT OF ENGLISH SHEEP

By the time Robert Bakewell of Dishley (1726 to 1795) ntered the livestock-breeding business of England, wool had eclined in price until—with the rapidly advancing values of nglish lands—it alone would no longer justify the keeping of heep. Bakewell, however, had the foresight to picture the future eeds of a growing population in terms of meat, and he set about mproving the Leicestershire sheep of the day. He was successful n creating a low-set, blocky, quick-maturing type of animal. He aid little or no attention to fancy points; no animal met with his avor unless it had utility value, as measured by meat over the lock. Bakewell gradually transformed the large, heavy-boned nd heavy-framed sheep, that had little or no propensity to fatten

quickly, to a shorter-legged, blocky form with finer bone and quick-fattening propensities. Other breeders followed suit.

EARLY IMPORTATIONS AND IMPROVEMENTS OF SHEEP IN THE UNITED STATES

The Big Horn or Rocky Mountain sheep, prevalent in the Rocky Mountain region from Alaska to California, were native to this continent, but the ancestors of our present-day domestic sheep were imported. The Spanish explorer, Columbus, brought



Fig. 192. Hairy, multi-colored, unimproved Navajo sheep in the Navajo Reservation, New Mexico. It is thought that the ancestors of these sheep were brought to America from Spain by the Spaniards who founded old Santa Fe. (Courtesy, J. O. Grandstaff, Southwestern Range and Sheep Breeding Laboratory, Fort Wingate, New Mexico.)

sheep and goats to the West Indies on his second voyage in 1493. Cortez brought Merino sheep into Mexico in 1519. The Spaniards who founded old Santa Fe, New Mexico, were thought to have brought in the multi-colored sheep from which the flocks of the Navajo Indians have descended. If, as is generally supposed, these early importations were of Spanish Merino extraction, special permission to take them out of Spain must have been granted by the king.

The first sheep of the British breeds to be introduced in this country are said to have been brought into Virginia by the London Company in 1609.[1] Two decades later, there were as many

[1] In 1607, a shipment of sheep came over in the Susan Constant, but these were consumed during the famine of the ensuing winter, thus having no permanent effect.

four hundred sheep in Charleston, now a part of Boston. We told that these early importations represented very poor cimens of British sheep, the imperfections of which were erally acknowledged. Furthermore, because of the lack of e, inadequate shelter, and promiscuous breeding, the sheep dded a wool that had lost all pretense to fineness. Predatory mals played havoc with the flocks, and for this reason many the early sheep were herded on small islands off the coast. en today, sheep are to be found on the islands off the coast of ine and Massachusetts, especially on Martha's Vineyard and ntucket.

Sheep husbandry was promoted by the colonist primarily order to furnish wool rather than for purposes of increasing food supply. In addition to the demand for wool in most new ntries, the product is well adapted to marketing in an un-eloped area—being (1) light in weight, value considered, and imperishable with respect to time involved in getting it to rket.

As early as 1662, there was a woolen mill at Watertown, ssachusetts. At about this same time, the exportation of ewes lambs, except to other Colonies, was forbidden. In 1670, in der to encourage sheep growing, Connecticut required every rson to labor for one day each year at clearing the underwood make pasturage. Drastic legislation was passed by all the New gland colonies to protect the sheep from dogs. A dog that bit killed a sheep was often hanged as though he were a human lefactor. The execution was usually carried out in some nearby amp, whence comes the name "Hang-Dog Swamp," given to veral localities in colonial Massachusetts and Connecticut.

The town common was open to all kinds of livestock, but cause sheep were the most defenseless of domestic animals d the hardest to raise, the town regulations concerning their re were numerous. Moreover, each town had one or more shep-rds who were considered very important persons.

Owners identified their stock by marks or brands (ear-tches or earholes were the most common means of marking)—Medieval European device revived in the New World. These arks were registered with the town clerk, and sometimes the scription was embellished with a crude picture.

In due time, early importation to America and the improve-nts made by the colonists were to become the sturdy basis r some of our great American flocks. Breeding stock was im-

ported from some of the foreign countries; and the early flock owners practiced rigid selection in order to improve the quality of wool produced, employing sight and touch, ordinary scales for weighing the fleeces, and in some instances a ruler for measuring fiber length. These empirical methods served well, however, and remarkable improvements in wool were brought about. Fleeces became heavier, and the fibers were longer and more uniform. It is also interesting to note that in the year 1836 fleeces produced in this country averaged only about two pounds in weight and were satisfactory only for the coarser woolen fabrics. Half a century later the average weight had been increased to five and one-half pounds. Almost simultaneously, the growing importance of the lamb and mutton trade changed the character of the sheep from one with a small carcass and with a short, fine fleece to a heavier and larger animal growing a longer-stapled and coarser-grade wool. Thus a dual-purpose type of animal was developed.

THE MERINO CRAZE

As early as 1660, England had forbidden the export of sheep and wool from any of the American colonies, a prohibition that marked the beginning of the oppressive trade measures that finally helped drive the colonies into rebellion. The British parliament also forbade the export of blooded English rams to the colonies in order to prevent improvement of the sheep across the water. Despite these restrictions on the part of the home government, the sheep industry rapidly increased in New England. But America's dependence upon English wool was a source of great chagrin.

Napoleon's invasion broke Spain's jealous guardianship of the Merino, a breed monopoly that had prevented their earlier introduction to America. President Jefferson promptly learned of the great liquidation of the Spanish flocks as a result of invasion, and he at least encouraged their importation, although he did not actually activate the project. James Madison, Jefferson's lifelong friend and successor to the presidency, was also a sheep fancier, who often found relaxation from the burden of public affairs on his Virginia farm.

Because of the scattering of the native flocks of Spain and the political turmoil that accompanied the fall of Napoleon, the importation of Merinos from Spain was of comparatively short duration.

The American farmer discovered the advantage of wool wing, and the demand for wool was all the heavier because pments of English wool were stopped by the War of 1812. In 1, Merino wool sold at seventy-five cents per pound, and by 3 it ranged from two to three dollars per pound. Profits red, and the demand for Merino sheep became a craze which ended from New England to Ohio. As Spain could no longer pply Merinos and the numbers in the states were inadequate meet the demands of the boom, American breeders and traders ned to the flocks of Saxony in Germany. Some years before poleon's invasion of Spain, the King of Spain had presented chief ruler of Saxony with a number of Merinos. The pure xony Merinos were of high quality, and they thrived most cessfully in their adopted land in Germany. Unfortunately, ny of the sheep advertised as "pure blooded Saxons" and sold sheepmen in the United States were only grades.

A wave of speculation swept the country. The wildest of ims were fabricated about the yield and quality of the fleeces duced by this marvelous Merino breed. Unfortunately, little ention was given to any characteristic other than the wool lf. In the wild boom, the enthusiasts had failed to foresee that prices of wool were inflated by the temporary halt in British petition and (2) the constitution of the Merino had danger- ly declined through lack of intelligent selection. Finally, when war with England ended in 1815, British woolen goods began flow in again and gradually forced down the inflated prices American wool. Eventually, the Merino bubble burst, and with vent much of the myth that had surrounded the breed. Sheep sing did not again get on its feet until the tariffs of 1828, ich helped to protect the American sheep grower and the erican woolen manufacturer against outside competition. It to the everlasting credit of the Merino breed of sheep, how- r, that they continued to multiply and form the sturdy ndation for much of the sheep industry of America.

E WESTWARD MOVEMENT OF SHEEP

In 1810, the census figures clearly indicated that the north- tern part of the United States—New England and New York vas the sheep-producing center of the nation. At this date, re were an estimated seven million head of sheep in the ited States. By 1840, sheep numbers in the United States had reased to nineteen million head. At that time there were no preciable numbers of sheep in the far West except those

owned by the Navajo Indians in northern New Mexico. In fact, the only state west of the Mississippi having sheep in considerable numbers was Missouri. Ten years later, the densest sheep population was centered in the Ohio Valley and Great Lakes region. When this area became somewhat thickly settled and land values rose, many sheepmen, desiring to operate on a large scale, moved farther west where range was cheap and extensive. It must be remembered that during this period sheep were maintained primarily for wool production and that the market-lamb business, as we know it today, was practically unknown. It was not at all surprising, therefore, to find that with the opening up of cheaper range lands in the West there was also an immediate and marked shift of the sheep population from East to West.

Like other wars, the Civil War caused sharply increased sheep numbers as a result of the demand and the high price of wool. Following the war, wool prices fell because of lower demand and increased competition from cotton and imported wool. Yet the westward expansion and the opening up of cheap lands continued.

THE GROWTH AND DECLINE OF THE UNITED STATES SHEEP INDUSTRY

By 1890, sheep were to be found in all the western states and territories, and, by 1900, the Rocky Mountain region had become the most important sheep section of the country. Of the sheep in the United States, the western range area claimed over 58 per cent in 1910, 60 per cent in 1920, and 70 per cent in 1947.

During the last two decades, the wool growers of the country have produced approximately 300,000,000 pounds of wool annually. In addition to this, the woolen mills of this country have utilized about an equal quantity of imported wool. It is also interesting to note that practically all the lamb produced in this country has been consumed here and that only a very negligible amount has been exported. The sheep production of the United States, therefore, is certainly on a domestic basis. These facts indicate that a flock that is intelligently managed should pay good returns for some time to come.

During the last half century, the sheep business has changed from a wool business to a combined wool and market-lamb business, with 65 to 75 per cent of the annual income now being derived through the latter source. Thirty years ago, a large percentage of the flocks were wethers, for these were more easily

dled and produced slightly heavier fleeces than the ewes. The ep producer of today, however, finds himself in different petition. He must now produce a high-quality, well-finished b carcass that will reach a market weight of seventy to nty-five pounds at an early age. In addition, he must produce eavy fleece of merchantable wool that will meet the needs of textile mills.

STOCK SHEEP AND LAMBS: NUMBER ON FARMS, UNITED STATES, JANUARY 1, 1867-1949*

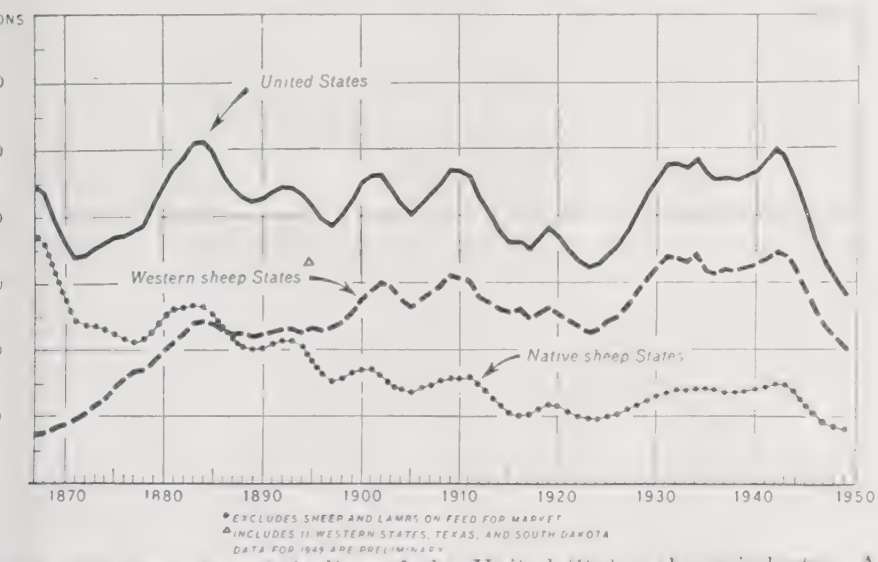


Fig. 193. Growth and decline of the United States sheep industry. At present time, there are fewer sheep in the United States than in any od since the Civil War. (Courtesy, U.S.D.A., Bureau of Agricultural nomics.)

Figure 193 shows that sheep numbers are not static. Soon r the beginning of the war, range sheep numbers were sharply uced despite the abundant availability of range grasses. The uctions were primarily due to (1) the scarcity of herders, uncertainties in wool prices, and (3) greater remuneration n grain crops and cattle with less effort. On January 1, 1950, re were fewer sheep in the United States than in any period e the Civil War, and the per capita consumption of lamb was than the per capita consumption of broilers.

E SAGA OF SHEEP AND WOOL IN WORLD WAR II

The American fighting man of World War II was the best-hed and warmest-clad soldier in the world. In combat, the ase-wool requirements per man the first year in service

amounted to approximately two hundred and forty-seven pounds. Thus it required the wool from about thirty sheep to outfit a soldier for combat duty. Moreover, the maintenance for the second year was approximately ninety-five grease pounds, which required the wool from twelve additional sheep. To outfit each flying soldier—including helmet, coat, gloves, trousers, and boots—required the pelts from fifteen lambs.



Fig. 194. A U. S. Air Corps pilot of World War II clad for winter flying. To outfit each flying soldier required the pelts from fifteen lambs. (Courtesy, Tanners Council of America.)

From the outbreak of the war, the utmost resources of synthetic fibers were placed at the disposal of the government in an effort to find some substitute for wool. Success in this search would have opened to synthetic fibers the greatest of all markets—clothing, blankets, and other items in which the exclusive protective qualities of wool have always been indis-

sable and irreplaceable. Field tests proved wool supreme, with result that it was still the number one textile at the end of war.

It is under the extreme conditions of combat that the soldier ns the true merits of his equipment. What may have passed a good article in the bright lights of the show window or at even may have stood up in use on city streets is completely pped of the halo of glittering words—with which the art of ertising may have adorned it in peacetime—when subjected he rigors of the landing beach, the jungle, or the sands of desert. Under such rigorous circumstances, the true value of ipment is in terms of serviceability. A rifle that jams, a ridge that does not fire, or a pair of shoes that goes to pieces a critical march—when the nearest replacement may be many s removed—can mean the difference between life and death. vas under these conditions that wool as a fiber for military iles demonstrated its value during World War II.

The Axis armies were forced to maintain clothing standards siderably below those of our Quartermaster Corps. For exple, our government required the use of pure virgin wool; ereas, according to reports, Germany was forced to accept in tary clothing the addition of 20 per cent reworked wool (old s) and 10 per cent of a cellulose product. A large part of the fering and reverses of the German armies in the disastrous ssian winter campaign can no doubt be attributed to the orced use of substitutes for wool, which caused the Nazi des to become half frozen and ineffective. The plight of Italy no better. The ruthless, barbarous conquests of the Axis vers helped but very little in the matter of improving their l supply.

Throughout the war, there was great need for surgical ures for tieing up blood vessels and for sewing together the ues of wounds. Practically all absorbable surgical sutures, alled "cat gut," are made from sheep intestines, because these ures are absorbed by nature in the proper way following the ling process. Through the control of the nodular worm, largewith the use of phenothiazine, more sheep intestines were ilable for the manufacture of these vital sutures.

Despite labor shortages, it is also interesting to note that, ing the war years of 1941 to 1945, the annual production of b and mutton in the United States was increased by 21 per t over the prewar period of 1936 to 1940. Much of this in-

creased production was due to the decrease in sheep numbers, particularly on the western range. Fortunately, the liquidation did contribute to the total meat supplies, and the war ended before the shortages of lamb and mutton were in evidence. Thus sheep played a decisive role in the conflict of World War II, and historians are now recording that these animals were working on the side of free men everywhere.

CHAPTER XVII

DISTRIBUTION, ADAPTATION AND THE FUTURE OF THE SHEEP INDUSTRY

Despite the obscurity surrounding their domestication and disagreement about their ancestry and classification, it is vn that sheep raising followed the conquest and colonization ıe Western Hemisphere to Australia, New Zealand, South ca and other countries. Today, the sheep industry is world-, with numerous breeds providing needed adaptation. Like r industries, sheep raising is affected by wars, national and rnational policies, supply and demand, competition for land. r and capital, and many other factors.

RLD DISTRIBUTION OF SHEEP

As will be noted in Table 34, the United States is now ex-d in sheep numbers by Australia, Russia, Argentina, and a. Although the industry is world-wide, it is of greatest im-ance in those countries which have (1) vast frontier-land s that are sparsely settled and (2) temperate climates. These

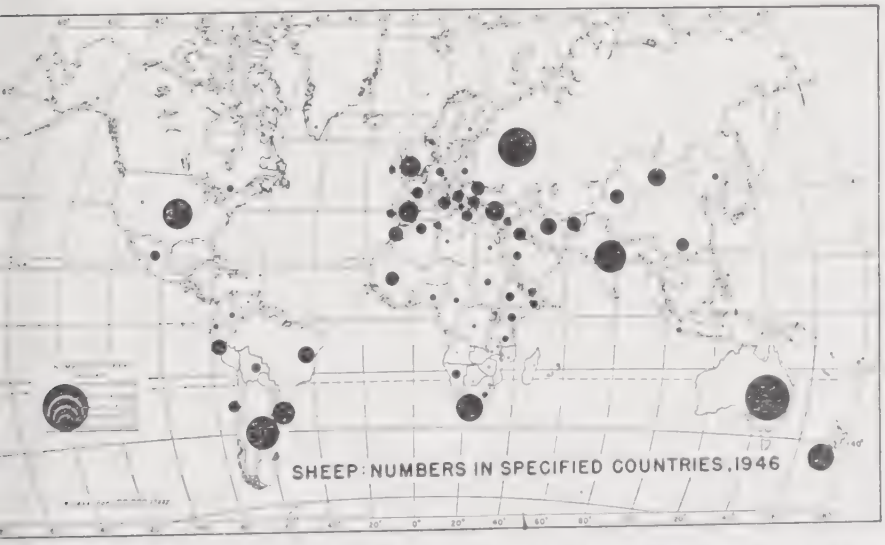


Fig. 195. World distribution of sheep, 1946. Although the industry is d-wide, it is of greatest importance in those countries which have vast frontier-land areas that are sparsely settled and (2) temperate tes. (Courtesy, U.S.D.A., Office of Foreign Agricultural Relations.)

conditions are more prevalent in the Southern Hemisphere, and it is there that most of the world's sheep are located. On the other hand, there are areas within countries of the Northern Hemisphere with many great flocks and numerous small ones.

The period during and subsequent to World War II had tremendous effects upon the sheep population. World sheep numbers in 1948 were estimated at about 714 million head, or 23 million head more than the preceding year. Although this represents a sizeable increase, world numbers are still below the 5-year average for the prewar period 1936 to 1940. In Europe, sheep numbers were less affected by war and feed shortage than most other types of livestock.

TABLE 34

SIZE AND DENSITY OF SHEEP POPULATION OF TEN LEADING SHEEP- AND WOOL-PRODUCING COUNTRIES OF THE WORLD, BY RANK

Country	Number of sheep[1] (thousands)	When esti-mated[1]	Human population[2] (thousands)	Sheep per capita	Area[3] (thousand) (sq. mi.)	Sheep per square mile
Australia	102,559	1948	7,581	35.85	3,000	35.6
Russia	64,800	1948	182,364	0.36	9,442	6.9
Argentina	53,500	1948	16,000	3.43	1,113	49.1
India (excluding Burma)	50,000	1947	365,900[3]	0.14	1,575[3]	31.7
United States	34,827	1948	142,656	0.21	3,620	8.4
Union of South Africa	33,000	1948	9,600	3.18	473	64.5
New Zealand	32,483	1948	1,793	18.68	104	322.1
Turkey	23,387	1947	17,566	1.02	295	60.9
China	22,000	1947	491,000	0.04	4,457	4.9
Uruguay	22,000	1948	2,218	0.99	72	305.6
Estimated World Total	714,900	1948	2,170,200	0.33	51,235	13.9

[1] *Agricultural Statistics*, U. S. Dept. of Agri., 1949, pp. 378-9.

[2] J. Whitaker, *Whitaker's Almanac for 1948*, London, England, pp. 193-198.

[3] *The Economic Almanac for 1948*, National Industrial Council Board, New York, N. Y., 1947, pp. 1-5, 264.

United States sheep numbers, totaling 34,827,000 in 1948 were the lowest of any year since the Civil War. By comparison it is interesting to note that there were 46 million head in the thirties and a peak of 49 million in 1942. The uncertainties relative to wool prices, scarcity of herders and high wages, and more profitable, alternative farm enterprises have taken their toll. Many sheep operators have either retired or gone over into cattle, and few young men have entered the business.

Favorable prices for wool and lambs and satisfactory grazing and weather conditions usually make for stable or increased

p numbers in those countries to which they are adapted. orically, wars have always played a prominent part in stimu- g the sheep business, and the cessation of conflict has usually followed by a decline in demand for wool and often ruinous es. World War I was no exception. The recent conflict may e to be somewhat of an exception, for sheep numbers were tically reduced.

Following a discussion of world wool production, a brief orical review will be given of each of the leading sheep coun- s of the world. The sheep industry of the United States will iscussed in a separate section.

RLD WOOL PRODUCTION

Inspection of Table 35 reveals that, generally speaking, there uite a close correlation between sheep numbers and wool pro- tion. On the contrary, Russia is somewhat of an exception his regard, ranking second in sheep numbers but fourth in l wool production. As might be deduced, this is due to Russia's low wool production per ewe. Australia, with a billion nd clip, produces 26 per cent of the world's wool at the pres- time. Thus, it can be clearly understood why it was so ortant to keep the sea lanes open to Australia during the nt conflict. The Southern Hemisphere countries of Australia, Zealand, Tasmania, and South Africa and the South Ameri- countries of Argentina, Uruguay, and Chile are the main l surplus producing areas. As would be expected, with the

TABLE 35

WOOL (GREASY BASIS) PRODUCTION IN TEN LEADING COUNTRIES OF THE WORLD, BY RANK, 1948[1]

Country	Wool Production (million lbs.)	Number of Sheep (thousands)	Wool Produced Per Sheep (pounds)
ralia	1065.0	102,559	10.38
ntina	419.0	53,500	7.83
Zealand	335.0	32,483	10.31
ia	304.6	64,800	4.70
ed States	280.5	34,827	8.05
n of South Africa	210.0	33,000	6.36
guay	149.9	22,000	6.81
n	88.0	20,183	4.36
ed Kingdom	75.0	18,164	4.13
a	75.0	22,000[2]	3.41
ld Total	3720.0	714,900	5.20

[1] *Agricultural Statistics*, U. S. Dept. of Agri., 1949, pp. 392, 378, 379.
[2] Data for 1947.



Fig. 196. Mustering (called herding in the United States) sheep in Australia. Note that horses are used. Australia has wide, flat grasslands. (Courtesy, The Wool Bureau, Inc.)

declining sheep numbers in the United States, the production of wool has been correspondingly lowered in this country.

Wool production is definitely a frontier industry, thriving in those areas where there is an abundance of cheap range area and where the human population is sparse. On the other hand, wool consumption is greatest in centers of dense population, especially the temperate zone of the Northern Hemisphere. Prior to World War II, the leading importing countries were the United Kingdom, France, Germany, United States, Belgium and Japan.

Sheep Raising in Australia

Australia holds undisputed claim to being the leading sheep country of the world, having more than one-sixth of the world's sheep and producing one-fourth of the world's wool. It is a large country which is best suited to a pastoral type of agriculture and in which sheep seem to have been the animals best adapted to her grazing lands.

Although sheep existed in Australia at an early date, the Merino was first introduced in 1789. Other Merino importations followed, most of which came from Saxony in Germany. The early sheep industry of Australia was financed with English capital, the original aim being to render that country independent of Spanish, German, and other foreign sources of supply. The

from the Australian Merino flocks met with a ready demand he part of English manufacturers, thus giving great en- agement to the further expansion of the sheep industry ustralia.

Merino blood still predominates in Australian flocks, al- gh the mutton breeds are gradually increasing in favor greater attention is being given to the mutton qualities of Merino. Most of the wool is marketed in England. Likewise, tralia disposes of her surplus mutton by shipping frozen asses to England.

Most of the flocks of Australia are kept in fenced holdings, er than being herded as is the most common practice on the tern ranges of the United States. The Australian owners er ranging on enclosed lands, contending: (1) that the sheep e better use of the range under this system, the animals tering out in contrast to each sheep regularly maintaining irly definite position in the band as happens in herding; (2) less driving is required, as, in herding, the animals must be nded into camp at night, driven to water, and kept from other ds of sheep; (3) that the fences cost less than the added r in herding; and (4) that the fences give considerable pro- ion against predatory animals and help protect the forage n the ravages of rabbits (the fences being rabbit proof). perienced operators contend that handling sheep in fenced dings is satisfactory provided that the band can be kept under se conditions the year around but that it will not work if the nals must be removed from fenced range at intervals and ded, for the band will then be untrained and unmanageable.

ep Raising in New Zealand

New Zealand is a small country, less than twice the area of state of Illinois. In 1948, however, there were 32,483,000 ep in this country, or 322 sheep per square mile. New Zea- l, therefore, has the densest sheep population of any country he world. The sheep of this country run more to the mutton e than do the animals of Australia. Practically all the flocks kept in fenced holdings without herders, in a manner similar the method followed in Australia. Year around grazing is ilable. It is reported that the best lambs in New Zealand are duced by using Southdown rams on Romney ewes.



Fig. 197. Newly shorn sheep departing from well-equipped yards and shearing shed in Wellington Province, North Island, New Zealand. New Zealand has the densest sheep population of any country in the world. (Courtesy, Dept. of Scientific and Industrial Research, Wellington, New Zealand.)

Sheep Raising in South America

There is a considerable sheep industry in Argentina, Chile, Uruguay, Brazil, and Peru.

Without doubt, the finest sheep country in South America and one of the finest in the world is in the La Plata River area of Argentina and Uruguay, where sheep compete with cattle for the lush pastures of the Pampas region. Predatory animals are few; winter feeding is seldom necessary; and diseases are rare. In brief, it has been said that there is probably no other comparable area in the world where the shepherd's life is easier than in this particular territory. Sheep raising in other areas and countries of South America does not compare with the La Plata River section, either in terms of favorable conditions or quality of flocks.

In all the South American countries, Merino breeding was used as a foundation and in effecting improvement, but many subsequent importations of the mutton breeds have been made, especially the long-wooled breeds. Much of the coarse wools produced in South America are used in the manufacture of rugs.

Sheep Raising in South Africa

The Union of South Africa's chief claim to fame as a sheep country is in terms of wool production. Merino blood predominates, although a considerable number of representatives of the

con breeds have been introduced in more recent years. The or handicaps to sheep production in South Africa are: (1) pre- nce of diseases and parasites, especially sheep scab; (2) un- ble labor, consisting of the natives for the most part; (3) atory animals, especially jackals; and (4) frequent droughts.



Fig. 198. Sheep scene in the Union of South Africa. Note that the sheep Merino breeding. (Courtesy, Union of South Africa, Government In- ation Office.)

ep and Wool Production in the United States

Beginning in 1942, sheep numbers on farms and ranches of United States drastically declined. On January 1, 1950, there e fewer sheep in this nation than in any period since 1867. eover, in terms of world sheep numbers, the United States ked fifth as a nation.

Except for the period during World War II, no appreciable ntities of mutton or lamb have been either exported or im- ted. During the five prewar years, 1936 to 1940, 2.5 million nds of lamb and mutton were exported annually; whereas, ing the war period, 1941 to 1945, the average annual exporta- was increased to 52.9 million pounds, an increase of 2016

per cent.[1] This large exportation came largely as a result of a sharp reduction in sheep numbers during the war years. The United States per-capita consumption of lamb and mutton averaged 6.7 pounds during the prewar period, 1936 to 1940, and 6.9 pounds during the war years, 1941 to 1945, an increase of only 3 per cent.[2] Therefore, lamb consumption in this country (and most of it is lamb and not mutton) is about 10 per cent that of beef or pork. For the most part lamb consumers are found in the higher-income groups among the population and in the northern and eastern parts of the United States.

During the war years, 1941 to 1945, imports of wool averaged 665 million pounds,[3] considerably more than the home production. Even before the war, the United States was on an import basis for wool. Prior to 1940, much of our imported wools came from China, Japan, and South America and, for the most part, were the coarser wools used for carpets, and other similar products. During the war, a considerable quantity of fine wool was brought into this country from Australia and New Zealand.

In peacetime, the average United States per-capita consumption of wool is roughly about four pounds, but during the war the amount rose to eight pounds. The average clip for all of the sheep in the United States is about eight pounds per head.

Areas of Sheep Production

Sheep raising in the United States may be divided into two areas, namely (1) the range-sheep states, and (2) the farm-flock-sheep states. Each of these areas will be discussed separately.

THE RANGE SHEEP STATES:

About 70 per cent of the breeding or stock sheep of the nation are in the seventeen western range states. For the most part, this type of sheep husbandry is characterized by large bands of from 1,000 to 1,500 ewes under the care of a herder. In general, these bands are run on unenclosed land. As more than half of the ranges of the West are publicly owned and are

[1] *The Livestock and Wool Situation, 1946*, U. S. Dept. of Agri., Bur. of Agri. Econ. Situation Report, May-June, p. 15.

[2] *Livestock, Meats, and Wool Market Statistics and Related Data*, U. S. Dept. of Agri., 1945-46, Prod. and Market. Admin. Mimeo. Pamphlet, p. 78.

[3] Hopkins, Howard Daniel, *The Livestock Industry's War Contribution*, State College of Washington, 1948. (Thesis).

ly to continue so, fences will not be built simply because it is wise to go to so much expense on other than private holdings. the other hand, scarcity and high cost of labor has resulted fencing a considerable amount of private holdings in south-tern United States. As most of these ranges are used the year und and the bands are not herded on mountain ranges during summer months, fenced range has been satisfactory.

Within the western range, there are great variations in ography, rainfall, and vegetation. Thus, in most cases, the ep production of this territory is a migratory type of enter-se, in which deserts, plains, foothills, and mountains may be d during different seasons of the year in such manner as to ain as nearly year-around foraging as possible. In general, ranges of the southwestern states do not afford sufficiently d grazing to produce milk-fat market lambs. Wool production h Rambouillet type sheep, therefore, is of comparatively ater importance in this area than it is in the Northwest. On better ranges of the Northwest, however, the objective is ays that of producing a fat market lamb at weaning time, and der lambs only result because the ranges proved inadequate rhaps through lack of moisture) or because of the usual ects in culling. Because the vegetation is more abundant in Northwest, a larger, crossbred type of sheep predominates in s area. This type produces a coarser fleece than the Rambouil-type ewes of the Southwest, and they also yield lambs of re desirable type and quality.

Most of the better range operators provide supplemental ding during a part of the year, especially in the lambing sea- and during times when the range is covered with snow. alfa from the irrigated areas is the chief hay crop; and corn, s, barley, and various protein supplements may be used on asion. In the trade, wools produced in the range states are wn as "territory wools."

E FARM FLOCK SHEEP STATES:

This includes the sheep production throughout the United tes, except in the seventeen western range states. It embraces farm flocks, often containing twenty-five sheep or less and dom more than four hundred to five hundred, which are kept the farms of the East, South, and Middlewest of the United tes. In the trade, the wool coming from farm flocks is known "native wool."

Many of the smaller farm flocks of this area are primarily kept as scavengers, and, unfortunately, they are often accorded the neglect of a minor enterprise. In general, the lambs from farm flocks are sold directly for slaughter, only a few finding their way to feed lots for further fattening. Farm flocks carry a heavier infestation of parasites than do range bands, and the fleeces lack the care and uniformity accorded to range wool production. Also some lambs coming from farm flocks are not docked or castrated, a neglect which is a rarity on the western range where sheep production is more of a specialty.

Purebred flocks as well as commercial enterprises characterize the farm sheep flocks. The purebred producer markets his surplus stock to (1) other purebred breeders and (2) as breeding stock for commercial enterprises.

TABLE 36

TEN LEADING STATES IN STOCK SHEEP AND LAMB NUMBERS[1] BY RANK, 1949, WITH AVERAGES FOR 1944-1948[2]

State	Average 1944-1948	1949
Texas	8,875,800	6,508,000
Wyoming	2,574,000	1,980,000
Montana	2,519,000	1,865,000
California	2,149,000	1,652,000
New Mexico	1,642,200	1,393,000
Utah	1,600,400	1,381,000
Colorado	1,210,400	1,210,000
Missouri	1,210,400	1,054,000
Idaho	1,227,400	1,053,000
Ohio	1,284,800	979,000
United States Total	22,327,000	27,651,000

[1]The classification "stock sheep and lambs" does not include sheep and lambs on feed for market.

[2] *Livestock Market News, Statistics, and Related Data*, 1947, U. S. Dept. of Agri., July, 1948, p. 2.

Ibid., 1949, August, 1950, p. 2.

Leading States in Sheep Production

Some idea of the relative importance of sheep production in the leading states may be obtained through studying Table 36.

As will be noted, Texas has a substantial lead in sheep numbers, a position which it also holds in cattle, horse, and goat numbers. In fact, the leading sheep states are predominantly in the range-sheep area of the United States.

CTORS FAVORABLE TO SHEEP PRODUCTION

As compared to other classes of livestock, sheep possess the owing natural advantages:

1. Sheep are unexcelled, though they may be equalled by cattle, in the utilization of the more arid type of grazing.

2. In the farm flock states, sheep utilize what would other- be wasteland. They are also excellent scavengers, gleaning s and destroying weeds.

3. Compared to cattle, sheep produce more liberally in pro- ion to what they consume.

4. Sheep produce two products, lamb and wool, which are ilable for market at two different periods of the year, and it om happens that both products sell at bottom prices the same r.

5. The returns come quickly. Lambs may be marketed eight ths after the ewes are bred.

6. The sheep's habit of bedding down on the highest areas he field or range leaves the larger part of the droppings at places where they are most needed. Moreover, the form in ch sheep manure is dropped and the way it is tramped into soil insures a smaller waste than is possible under any other tem of stock farming.

7. The wool clip is easily stored and shipped, thus making l production ideally suited to a frontier type of agriculture.

CTORS UNFAVORABLE TO SHEEP PRODUCTION

There are, however, some factors which are quite unfavor- e to sheep production as many sheepmen will testify to their ret. Some of these are as follows:

1. Wool has always been in politics, and it is apt to so ain. It is rather difficult, therefore, to predict prices over a g period of time.

2. Sheep are very much subject to attack from numerous datory animals, including the dog.

3. When disease or injury strikes, sheep have less resistance n other classes of livestock.

4. Herding is not a particularly attractive profession, thus ulting in a scarcity of satisfactory herders.

5. Sheep are quite susceptible to a number of very devas- ng parasites.

THE FUTURE OF THE AMERICAN SHEEP INDUSTRY

United States sheep production is very much on a sound basis. In fact, many far-seeing stockmen feel that the sheep business offers the brightest future on the entire livestock horizon. No negligible amounts of lamb or mutton are either exported or imported, and the United States per capita consumption of these products is very small in comparison to the consumption of beef or pork. To be exact, mutton and lamb account for only 3.4 per cent, or approximately five pounds per capita of the nation's meat at the present time. Moreover, the United States is producing only a fourth to a third of its domestic wool needs. World wool stocks are shrinking and fine wools are especially scarce.

On January 1, 1950, there were fewer sheep in the United States than in any period since the Civil War, and the per capita consumption of lamb was less than the per capita consumption of broilers. Since 1950, sheep numbers have increased, gaining impetus from favorable prices for lamb and wool, from abundant available range forage, and from new advances in parasite control.

CHAPTER XVIII

TYPES AND BREEDS OF SHEEP

In no other class of farm animals have so many breeds
ved as in sheep. As domestic sheep were improved in various
s of the world, the producers within different geographical
as soon became convinced that the animals under their care
sessed special attributes not found in more distant flocks.
of this thinking has arisen the approximately two hundred
erent breeds of sheep that exist today. Many of these breeds
of little importance in commercial production, with more than
ee-fourths of the industry of the world based on the use of
more than six breeds. Even so, breed enthusiasts are usually
ferous about the relative merits of their particular breeds, no
ter how small the numbers.

ASSES AND BREEDS OF SHEEP

Breeds of sheep may be and are classified on several differ-
bases, including (1) their degree of suitability for mutton or
l production (mutton or wool type), (2) color of face (white
black face), (3) presence or absence of horns (horned or
ed), (4) topography of the area in which they originated
ountain, upland, or lowland), and (5) type of wool produced.
h system of classification has its special merits, but perhaps
assification based on type of wool produced is as good as any.
following summary shows the most common United States
eds of sheep classed according to type of wool produced:

ine-wool type	Medium-wool type	Long-wool type	Crossbred wool type	Carpet-wool type	Fur type
rican	Cheviot	Cotswold	Columbia	Black-faced	Karakul
erino	Dorset	Leicester	Corriedale	Highland	
ine	Hampshire	Lincoln	Panama		
erino	Oxford	Romney	Romeldale		
bouillet	Shropshire				
	Southdown				
	Suffolk				
	Tunis				

In general, all of the breeds listed within each of six wool-
e categories produce wool of a similar character, especially
n the standpoint of diameter and length of fibers.

RELATIVE POPULARITY OF BREEDS OF SHEEP

Table 37 shows the 1949 and total registrations to date of the common breeds of sheep. Although the annual figures for 1949 are probably more meaningful at the present time than the all-time registrations, it is recognized that one year's data fail to show trends. Without doubt the Columbia and Suffolk are the fastest growing breeds of sheep in America today.

TABLE 37

1949 AND TOTAL REGISTRATIONS OF SHEEP IN UNITED STATES BREED ASSOCIATIONS[1]

Breed	1949 registrations	Total registrations
Hampshire	26,960	809,970
Shropshire	15,557	1,130,750
Corriedale	12,188	105,230
Suffolk[3]	11,035	79,730
Rambouillet	9,788	523,926
Southdown	8,142	200,574
Columbia	6,023	———
Oxford	4,000	198,000
Dorset	3,487	79,135
Romney	1,851	29,000
Merino[2]	1,842	336,322
Karakul	661	19,870
Lincoln	491	69,001
Cotswold	223	126,595
Black-Faced Highland	———	———
Cheviot	———	———
Leicester	———	———
Panama	———	———
Romeldale	———	———
Tunis	———	———

[1]*New England Homestead*, Springfield, Mass., Sept. 23, 1950, Vol. 128, p. 40.

[2]Includes registrations in both the American and Delaine Merino and the Black-Top National Delaine Merino Associations.

[3]Includes registrations in both the American Suffolk and the National Suffolk Associations.

FINE-WOOL BREEDS

The common fine-wool breeds of the United States are the American Merino, Delaine Merino and Rambouillet. All of these breeds are of Spanish Merino extraction and really represent different types or ideals of Merinos brought about through selection. Because of their common ancestry, therefore, the three breeds still possess many characteristics in common. All of them are noted for fineness of wool and a great amount of yolk; the

ce sometimes loses over 70 per cent in weight in scouring. In neral, modern purebred animals of these breeds are of more eptable mutton conformation than formerly, although they are equal to the mutton breeds in this respect. The fine-wool eeds are hardy, gregarious, long-lived and well suited to pro- ction under range management methods throughout the world.

e Merinos

No breed of sheep has contributed so much as the Merino to development of the world-wide sheep industry. The Merino rnished the foundation breeding so necessary for the produc- of fine wool and the deep-rooted flocking instinct that has de it possible for a herder to watch over the welfare of a large nd.

Because of their common origin and considerable similarity, American and Delaine Merinos will be discussed together. e chief distinction between the two breeds is the degree of skin ds, the more wrinkled American Merinos being the "A" and " types and the comparatively smooth Delaine Merinos being "C" type.

IGIN AND NATIVE HOME:

The American and Delaine Merino are descended entirely m the Spanish Merino; representatives of the latter were in- duced into this country at the close of the eighteenth and the ginning of the nineteenth century. The word Merino is derived m an early-day royal officer of Spain, called the Merino, whose ty it was to assign the various migratory flocks of the country their respective grazing grounds. In its native land, the Merino eed of sheep had long been selected for fine wool and strong cking instincts.

RLY AMERICAN IMPORTATIONS:

The first importation of Spanish Merinos of which there is thentic record was made in 1793 by William Foster, of Boston, assachusetts. Other importations followed, and gradually eepmen in this country molded the breed into several strains, ch of which they considered to be better adapted to their re- ective conditions. Originally, nearly every one of these strains d a separate record association. Finally, in 1906, most of these sociations were combined under the American and Delaine erino Record Association.

ERINO CHARACTERISTICS:

For the last half century, three types of American Merinos ve been recognized. Based largely upon the degree of skin



Fig 199. Three types of Merino ewes: (1) The "A" type (top picture) is the smallest and has the greatest development of wrinkles; (2) the "B" type (center picture) is intermediate in skin folds between the "A" and "C" types; and (3) the "C" type (bottom picture) is sometimes referred to as the smooth or Delaine Merino.) (Courtesy, U.S.D.A.)

lds, these are: the "A" type, the "B" type, and the "C" type Delaine Merino.

HE "A" TYPE

The "A" type (formerly known as the Vermont type) has e greatest development of wrinkles. The skin folds extend om the head to the dock and cover the entire body.

Sheep of this type are the smallest of the Merinos, mature ms weighing from 130 to 160 pounds and ewes from 90 to 120 unds. This wrinkly type decreased in numbers and value when perimental studies established the fact that skin folds are sociated with a lack of uniformity in fiber fineness, when it as realized that grease weight may not be a true indication clean wool yields, when lamb production increased in impor- nce and it no longer was considered profitable to maintain eep (including mature wethers) merely for wool production. d when sheepmen recognized that wrinkled skins were difficult shear. At the present time, the "A" type Merino is practically solete.

HE "B" TYPE

The "B" type has fewer skin folds than the "A" type. More- er, most of the wrinkles are confined to the neck, although ere may be some in the regions of the fore and rear flanks, ck, and thighs. In comparison with the "A" type, animals the "B" type possess superior body form and mutton qualities, creased staple length, less yolk, and less grease weight. These eep are intermediate in size between the "A" and "C" types, th mature rams weighing from 145 to 175 pounds and ewes om 100 to 135 pounds.

HE "C" TYPE OR DELAINE MERINO

These sheep are sometimes referred to as the smooth erinos. The states of Ohio, West Virginia, and Pennsylvania oneered in developing Merinos with smooth hide and better utton qualities. This strain of sheep became known as Delaine erinos.

The word "Delaine" was derived from the French fabric made om a certain grade of wool that these sheep were supposed to oduce.

The Delaine Merino is practically free from skin folds, al- ough they may have the folds to a slight extent on the neck d breast. The Delaine Merino is the largest of the three types, ature rams weighing from 150 to 200 pounds and ewes from

110 to 150 pounds. Delaine wool is the highest quality fine-wool produced in this country. It has a longer staple, more uniformity in fiber diameter, and less grease than that of the "A" and "B" type American Merinos.

It is to be emphasized that Merino sheep do not necessarily breed true to type. Although a "C" type ram crossed on "C" type ewes is more likely to produce "C" type lambs than a "C" X "B" type mating, sometimes twin offspring will represent two different types. Although the types differ in the intensity of skin folds, size, and body conformation, Merinos, in general, have strong constitutions and are noted for hardiness, flocking instinct, and longevity. The face and legs are white, and the skin is pink in color. Most rams have horns, but there are some polled strains.

As all three types are registered at the present time in the same association—the American and Delaine Merino Record Association, Xenia, Ohio—this explains better than any lengthy discussion the close resemblance that exists between all strains of Merinos. Even so, in common practice, smooth-bodied Merinos are still designated as Delaine Merinos and the more wrinkled types as American Merinos.

The Rambouillet

Like the American and Delaine Merinos, the Rambouillet is descended entirely from the Spanish Merino. For many years, grade Rambouillets have dominated the commercial range sheep industry of western United States, although more recently the increased competition of crossbred types has become an important factor. It has been estimated that approximately 50 per cent of all sheep in the United States carry some Rambouillet breeding.

ORIGIN AND NATIVE HOME:

During the reign of Louis XVI, France was producing only a small portion of the wool that was used in its factories. In an attempt to build up the nation's flocks, Louis XVI asked, as a personal favor of the King of Spain, that he be allowed to purchase some of the famous Spanish Merinos. His request was granted, and in 1786 a total of 366 head of choice large Spanish Merinos were taken to France and put on the King's estate at Rambouillet, about forty miles west of Paris. Other flocks were subsequently established in France and Germany, and later breeding stock from these was fused with those coming from Rambouillet. Out of these selections emerged the Rambouillet breed of sheep. From the beginning, the Rambouillet strain was

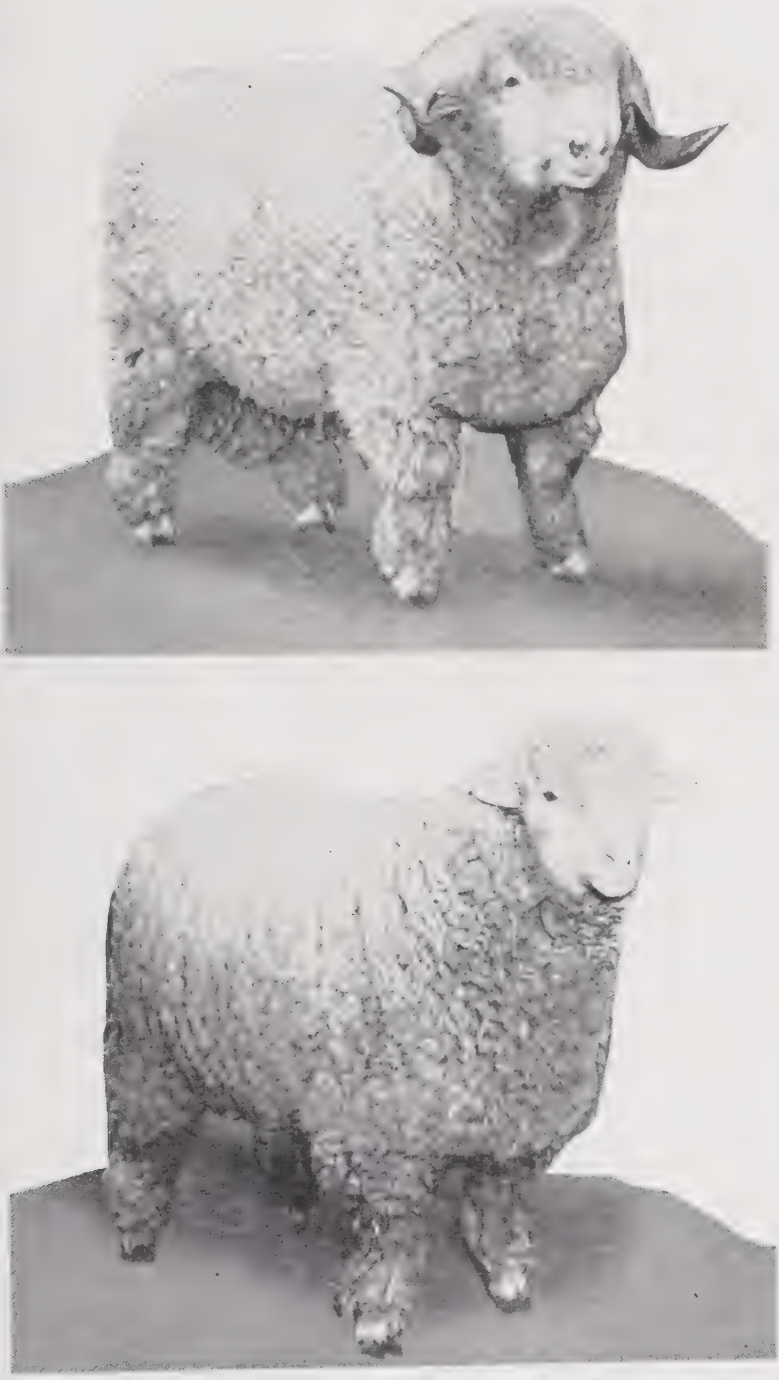


Fig. 200. Modern Rambouillets. (Top picture) Champion Rambouillet ad ram at the impressive San Angelo, Texas show in March, 1949. Bred d exhibited by Leo Richardson, Iraan, Texas. (Bottom picture) Ideal type mbouillet ewe, bred and owned by R. O. Sheffield, San Angelo, Texas. e ewe sheared 18 pounds of grease wool (10.4 lbs. of clean wool), grading 's, at 16 months of age.

selected and developed for greater size than the average Spanish Merino.

EARLY AMERICAN IMPORTATIONS:

D. C. Collins, of Hartford, Connecticut, first brought Rambouillet sheep to this country in 1840, importing fourteen ewes and two rams from the Royal Flock at Rambouillet, France. Other importations followed, and the breed rapidly increased in favor.

RAMBOUILLET CHARACTERISTICS:

Throughout the years, Rambouillet breeders have generally favored dual-purpose sheep, adapted to the production of both wool and mutton. However, it is not surprising to find that, from time to time, the emphasis has shifted between the fleece and the carcass.

In recent years, "B" type Rambouillets have largely disappeared, and the "C" type has been greatly improved. Modern Rambouillets are large, rugged, fast-growing sheep; almost free from skin folds—although an apron across the brisket is not usually considered too objectionable; of acceptable mutton conformation —although not equal to the mutton breeds; good wool producers —with open faces, long staple, fair density, uniformity, and moderate shrinkage. In brief, it is to the everlasting credit of Rambouillet breeders that they have been quick to recognize and accede to the demands of commercial sheep producers. As a result, the breed is now enjoying the greatest popularity in its history.

Mature rams in good condition and full fleece weigh from 225 to 275 pounds, and ewes weigh from 140 to 200 pounds. Most rams have large spiral horns, although polled strains exist. The face and legs are white, and the skin is pink.

MEDIUM-WOOL BREEDS

With the exception of the Tunis, all of the medium-wool breeds were developed in Great Britain. The Southdown, Shropshire, Oxford, Hampshire, and Suffolk breeds are collectively referred to as the "down" breeds, because of the nature of the country in which they were developed. This area in southern England is a country of hills or "downs." The "down" breeds came into prominence during Bakewell's time. From the beginning, they were bred primarily for mutton, with special emphasis on those characteristics considered important to the nature of the particular grazing lands and climatic conditions as well as on the market demands of the regions in which they were developed. The face and leg color of all the "down" breeds is some

ade of brown or black, and the fleece occupies a middle position tween the length and coarseness of the long wools and the treme fineness and density of the fine wools.

The medium-wool breeds have been popular in the farm-flock gions of the United States, and rams of the larger breeds have een extensively used in market-lamb production on the western nges.



Fig. 201. A champion Cheviot ram, bred and owned by Alvin Helms, lleville, Illinois. The Cheviot is a beautiful and distinctive sheep, especially ted for its style and alertness. The face and legs are open and covered th soft white hairs. (Courtesy, The Sheepman Magazine.)

he Cheviot

The Cheviot is a small and extremely hardy breed. Its mut-n qualities are excellent, but the fleece weight is not one of the rong points of the breed. The Cheviot has never become numer-us in the United States.

RIGIN AND NATIVE HOME:

The Cheviot breed of sheep is native to the Cheviot Hills hat form about thirty miles of the border country between Eng-nd and Scotland. As it has received most of its development

and improvement in Scotland, however, the Cheviot is classed as a Scotch breed.

The native land of the Cheviot sheep has a harsh climate, cold winters, and heavy snow. In the formative period of the breed, the animals were given little shelter and very little feed other than what they could rustle for themselves. Under these rugged conditions, the development of a hardy breed was inevitable.

EARLY AMERICAN IMPORTATIONS:

The first American importations of Cheviot sheep were brought to Quebec, Canada, in 1825; and the first introductions into the United States came thirteen years later, in 1838. Other importations followed, but the number of Cheviot sheep in this country did not increase perceptibly until the latter part of the nineteenth century. Even today, the breed is considered a comparatively minor one in the United States.

CHEVIOT CHARACTERISTICS:

The Cheviot is a beautiful and distinctive appearing sheep. It is stylish, alert, active, short legged, and blocky in appearance. The face and legs are bare of wool and are covered with short white hairs. Conspicuous black spots often appear on the ears and occasionally on the face and legs. The nostrils, lips, and hoofs are black. The Cheviot is a small breed, mature rams in good condition weighing 160 to 200 pounds and ewes from 120 to 160 pounds. The fleece weight is generally light, 5- to 7-pound clips being rather common. Both sexes are hornless, although scurs are sometimes found on rams. Few breeds are so well adapted to grazing on hilly pastures as the Cheviot. The breed has not been accepted on the western ranges, primarily because it does not herd well and produces a light fleece.

The Dorset

The Dorset breed is distinct among medium-wool breeds in that both the rams and ewes are horned. The ewes will breed out of season, and they are noted for their prolificacy and heavy milk production.

ORIGIN AND NATIVE HOME:

The Dorset, also known as Dorset Horn, is native to southern England, especially to the counties of Dorset and Somerset. Although the breed is of medium-wool type, it is not one of the "down" breeds. The native home of the Dorset is, however, rolling to hilly.

Although the origin of the Dorsets is clouded in obscurity, s known that they developed largely through selection. There ittle evidence that crossing with other breeds was of conse- nce. That crossing was of little importance is further attested oy the very fact that the breed is so different from the others t were available for infusion.



Fig. 202. A champion Dorset ram at the Royal Winter Fair, Toronto, ada. Both sexes of the Dorset breed are horned. The face and legs are tically free from wool and white in color. (Courtesy, Canadian Sheep eders' Association.)

RLY AMERICAN IMPORTATIONS:

The first Dorset importations into the United States were he year 1885, when E. and A. Stanford of England exhibited nall flock of these animals at the Chicago Fat Stock Show.

The Dorset is the only white-faced breed from southern gland that has gained any degree of prominence outside its ive land.

RSET CHARACTERISTICS:

The face, ears, and legs are white in color and practically e from wool. The nostrils, lips, and skin are pink. Both sexes horned. The hoofs are white. The breed is of medium size. ture rams in good condition weighing 175 to 250 pounds and es from 125 to 175 pounds. In type, the best representatives of



Fig. 203. A Hampshire flock in the land of their origin—Hampshire, England. Note that these ewes are open faced. (Farmer and Stock-breeder Photo, London, England.)

the breed compare favorably with the other medium-wool breeds, although the neck and body are sometimes inclined to be too long and the fleece may lack weight.

The ewes will breed out of season, and they are noted for their prolificacy and heavy milk production, factors that make them ideally suited to the production of hothouse lambs. Because the greatest demand for winter lambs is in the East, most Dorsets are raised east of the Mississippi River.

The Hampshire

Hampshire rams are probably used to a greater extent for crossing in the United States than the rams of any other breed. It is to be noted, however, that on the western range this position is being successfully challenged by the Suffolk, a breed whose crossbred get are free from wool blindness, have a smaller head and shoulders that make for less trouble at lambing time, and may have more size. Many modern-day Hampshires have lost some of the great size that contributed to making the breed famous.

It is claimed that the use of the more active Suffolk rams results in a larger lamb crop than can be obtained with the use of Hampshire rams.

ORIGIN AND NATIVE HOME:

The Hampshire sheep originated in the county of Hampshire in south-central England. The native sheep of this area were

ely of two strains: the Wiltshire and Berkshire Knot. Both ins were described as large and coarse, with mutton of me- re quality and light fleeces. Southdowns and Cotswolds were sed on this native stock; and out of this conglomerate breed- followed by years of selection, the Hampshire breed of sheep created.

RLY AMERICAN IMPORTATIONS:

Several flocks of purebred Hampshires appear to have been blished in the United States prior to 1860, but during the l War all of these were either destroyed or scattered. No npshire flock was intact at the close of the conflict. Importa- s in great numbers were resumed in the eighties, and soon breed reached a place of prominence that it still retains.

MPSHIRE CHARACTERISTICS:

The face, ears, and legs of the Hampshire are a rich, deep wn, approaching black; but to most observers the color is ply black. Both the ewes and rams are hornless, although



Fig. 204. Beau Geste, first prize Hampshire ram lamb at the 1946 ago International. Bred and exhibited by Wm. F. Renk & Sons, Sun rie, Wisconsin, and purchased by The State College of Washington. face, ears, and legs of the Hampshire breed are a rich, deep brown in —approaching black; both sexes are hornless; and the lambs are re- ned for their rapid rate of growth. (Courtesy, The State College of hington.)

small scurs may be present in the latter. The Hampshire is one of the largest of the medium-wool breeds and is exceeded in weight only by the Oxford and equalled by the Suffolk. Mature Hampshire rams in good condition weigh from 225 to 300 pounds and ewes from 150 to 200 pounds. The head is large, being in proportion to the rest of the skeletal make-up; and many rams possess a Roman profile. As a breed, Hampshires are of excellent mutton type, although many individuals are heavy in the shoulders, lack in spring of forerib, and are deficient in depth and fullness in the rear quarters. In general Hampshires do not shear a very heavy fleece; a flock average of 7 to 8 pounds is common. The wool is of medium quality, but black fibers are likely to be present, and the latter are objectionable from the viewpoint of the manufacturer.

The Hampshire breed is renowned for the rapid rate of growth made by the lambs. When well cared for, the lambs usually gain a pound or more a day from the time they are born until they are marketed. The ewes are prolific and good milkers.

The Oxford

The Oxford, the largest of the medium-wool breeds, is found scattered throughout the United States; but it is one of the less numerous breeds.

ORIGIN AND NATIVE HOME:

The Oxford breed of sheep originated in south-central England in the county of Oxford near the seat of the great university that bears the same name. Beginning about 1833, several progressive Oxfordshire farmers decided to develop a new breed through crossing Hampshire rams on Cotswold ewes, with some infusion of Southdown blood. Because of the diversity of the parent stock and the ideals sought, much lack of uniformity still exists in the Oxford breed today.

EARLY AMERICAN IMPORTATIONS:

The first American importation of Oxford sheep was made in 1846 by Clayton Reybold, of Delaware City, Delaware. Other importations followed. While flocks of Oxfords are now found throughout the United States, their distribution is more or less localized in communities.

OXFORD CHARACTERISTICS:

The most distinguishing characteristic of the Oxford is its great size. Mature rams in good condition weigh from 250 to 35[illegible] pounds and ewes from 175 to 250 pounds. The face, ear, and leg

or is lighter than the Hampshire, varying from gray to brown. e head and ears appear quite small in comparison with the size he body. Both sexes are polled, although the rams frequently e scurs or small horns. Many Oxfords are more upstanding n would be preferred. The frame is large, and the contour of body is rectangular.

Perhaps because of their Cotswold heritage, Oxfords shear vier than any other of the medium-wool breeds. They average to twelve pounds for unwashed fleeces. Although the fleece



Fig. 205. A champion Oxford ram at the Royal Winter Fair, Toronto, ada. The most distinguishing characteristic of the Oxford is its great . It is the largest of the medium-wool breeds. (Courtesy, Canadian ep Breeders' Association.)

y be somewhat open and lacking in density, the fibers are usu- 3 to 5 inches in length. This relatively long, loose fleece fur- r accentuates the size of the breed. Although the wool extends wn a little further on the face on an Oxford than on a Hamp- re, Oxford breeders have wisely and scrupulously avoided any dency toward wool blindness. A top-knot or tuft of wool on forehead is characteristic, especially when animals have been omed for the show.

Oxford ewes are prolific and good milkers. The lambs are ge and vigorous at birth, weighing from nine to twelve pounds

when dropped. Although the young make rapid growth, they do not reach market finish at as early an age as Hampshires. The Oxford is well suited to a diversified type of farming, but thus far the breed has failed to establish itself for cross-breeding purposes on the western ranges to any extent comparable with the Hampshire or Suffolk.

The Shropshire

In the United States, at the present time, the Shropshire ranks next to the Hampshire in popularity and number of registered purebreds. It must be admitted, however, that years of selection for extreme face covering, with inevitable wool blindness, have resulted in the loss of some of the popularity that the breed formerly enjoyed.

ORIGIN AND NATIVE HOME:

The Shropshire breed originated in central western England in the counties of Shropshire and Stafford. The early strains of sheep common to this area included the Morfe Common, Cannock Chase, and Longmynd. Using the native stock as a foundation, improvement was brought about through the infusion of Southdown, Leicester, and Cotswold blood. Eventually, through breeding and selection, this mixed ancestry was molded together; and by 1848, the type of sheep was sufficiently standardized to receive the name that it now bears, although the Royal Agricultural Society did not recognize it as a distinct breed until eleven years later.

EARLY AMERICAN IMPORTATIONS:

The first American importation of Shropshires was brought to Virginia in 1855. By 1880, the breed was well established in most of the farm-flock states.

SHROPSHIRE CHARACTERISTICS:

The Shropshire breed is noted for its profitable combination of mutton and wool qualities—which are in keeping with the primary objective in developing the breed as a "rent payer." Thus, in its truest form, it is a strictly "middle-of-the-road" sheep, being neither extreme in wool or mutton production. Only the Southdown is smaller in size. Mature Shropshire rams in good breeding condition weigh from 175 to 250 pounds and ewes from 135 to 175 pounds.

Although they do not possess the extreme mutton type of the Southdowns, the best specimens of the Shropshire breed are thick, symmetrical, smooth, and well fleshed.

The Shropshire fleece is quite heavy for the size of animal, ly long, medium fine, and of good quality. It is generally ded as three-eighths, although some of it is of sufficient fine- s to be graded halfblood. Average clips of 10 pounds after a iod of twelve months' growth are not uncommon.

The face, ears, and legs are a deep soft brown in color—a k color being discriminated against. Breeders also frown



Fig. 206. A first prize Shropshire ram lamb at the Chicago Interna- al, bred and exhibited by McKerrow Farms, Pewaukee, Wisconsin. The opshire breed is noted for its profitable combination of mutton and wool ities. (Courtesy, The Sheepman Magazine.)

n a reddish or rusty brown color, but a dark gray color is eptable. Both sexes are polled, although rams frequently have all scurs.

Because of the extreme wool covering over the face and s, little hair color is in evidence in present-day Shropshires. fortunately, in an attempt to perpetuate the greatest possible l covering, some purebred breeders have neglected important ity features. Many farm-flock owners and practically all ranch- are opposed to wool blindness and over refinement. Because of s situation, the Shropshire has lost much of its popularity

in recent years, and further decreases are inevitable unless this condition is rectified promptly.

The ewes are prolific and good milkers. A lamb crop of 150 per cent is not considered unusual. When of ample size and free from wool blindness, the Shropshire is considered an excellent utility animal by farm-flock sheep raisers. While Shropshire lambs do not rank with those of the Southdown breed in early market maturity, they probably more closely approach them than lambs of any other breed.

The Southdown

The Southdown breed represents the ultimate in mutton type. While it is the dominant breed in only a few areas, it is known in practically all sheep-raising countries of the world.

ORIGIN AND NATIVE HOME:

The breed takes its name from the chalk hills—called the South Downs—of Sussex County in extreme southeastern England, where it originated. From very early times, the native sheep of this district were famous for their fine mutton qualities. Pioneer breeders selected the best of the native stock and developed the breed known as Southdowns. As the oldest of the medium-wool sheep, they contributed to the foundation stock of all the other "down" breeds. Because of their early origin and almost universal selection for the best in mutton type, the Southdown breed is unexcelled from the standpoint of uniformity.

EARLY AMERICAN IMPORTATIONS:

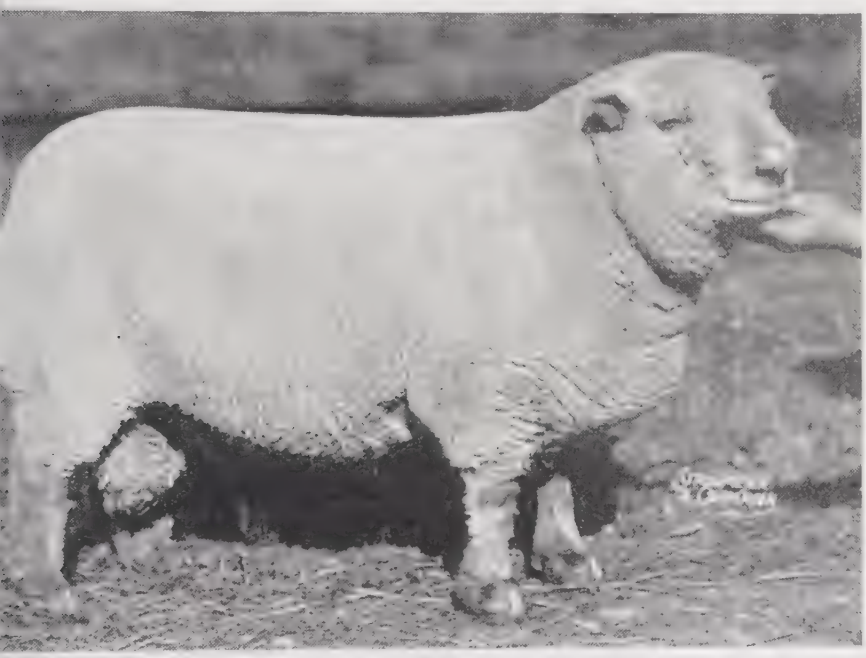
Historians are not agreed as to the date of the first Southdown importations to America, but it is known that they were introduced very early in the history of the nation. The American Southdown Breeders' Association was organized in 1882, but sheep of the Southdown type were introduced to America long before the breed was registered here or in England. Governor Winthrop, early Connecticut governor, is said to have acquired a flock of Southdown ewes in 1648.

SOUTHDOWN CHARACTERISTICS:

The body of the Southdown is compactly made, very wide and deep, full in the leg, and smooth and refined; the legs are short. The body symmetry and carcass quality are unsurpassed. The Southdown is the smallest of the "down" breeds, mature rams in good breeding condition weighing 175 to 225 pounds and mature ewes from 125 to 160 pounds.

The fleece—which is short, close, fairly dense, and of fine ty—weighs from 5 to 7 pounds unwashed. Very few animals ie breed are subject to wool blindness, although it is pre- d that short wool cover the forehead, cheeks, and backs of ars.

The preferred color of the face, ears, and legs is a steel gray, considerable variation exists, ranging from a light gray to a brown.



ig. 207. A champion Southdown ram at the Royal Winter Fair, To- Canada. The Southdown represents the ultimate in mutton type. It smallest of the "down" breeds. (Courtesy, Canadian Sheep Breeders' iation.)

The breed is hornless, although scurs are sometimes found ms. The ewes are not too prolific, and they are only average ilkers.

From the standpoint of early market maturity, Southdown s are unexcelled. For this reason, Southdown rams are used nsively with marked success for crossbreeding, especially he production of hothouse lambs. They also have been popu- n some areas, notably Kentucky, for the production of early g lambs.

Because of their small body size and light fleece, Southdowns not been accepted for crossbreeding purposes on the western e. Although lambs sired by Southdown rams and out-of-

grade Rambouillet or crossbred-type ewes grade higher—bo on foot and dressed—than lambs sired by rams of any oth breed, it must be remembered that: (1) the cost of produci range lambs is primarily on a per head rather than on a pou basis, thus giving weight for age a distinct advantage; and (at present the lamb markets of this country are not sufficient discriminating to pay adequate premium for a high quality pr uct. So long as these two conditions prevail, the range sheepm will favor the use of rams of the larger breeds for the producti of market lambs.



Fig. 208. Suffolks in their native county, on the farm of Sir B. G well, Suffolk, England. Note the large size and the uniformity of these (Farmer and Stock-Breeder Photo, London, England.)

The Suffolk

Although the Suffolk is a very old breed, it did not prominence in the United States until recent years. Wit doubt, it is now one of the fastest growing breeds in Ame Commercial range sheep operators of the West are using and more Suffolk rams for crossing on grade Rambouille crossbred-type ewes for market-lamb production. The chie vantages that practical sheepmen ascribe to the use of Su rams in comparison with present-day Hampshires are: (1) trouble at lambing time because of the smaller heads and s ders of the progeny, (2) production of lambs that are free wool blindness, and (3) production of lambs that are b rustlers. In addition, it is easier to secure large-type Su rams. In general, these attributes seem to be valid. Unles Hampshire breed can rectify some of its shortcomings, it w

ded a position of decreasing importance from the stand- of market-lamb production on the western range, with k rams increasing in numbers.

IN AND NATIVE HOME:

As a distinct breed, the Suffolk is comparatively young. It its name from Suffolk County—although the development red in Suffolk, Essex, and Norfolk Counties in southeastern



g. 209. Champion Suffolk ewe at the Grand National, San Francisco, Bred and exhibited by Walter P. Hubbard, Junction City, Oregon. The ommanding characteristic of the Suffolk breed is its very black, wool- ace, ears, and legs. The breed is also noted for its alertness. (Courtesy, can Suffolk Sheep Society.)

and, in the country bordering the English Channel. The was developed by crossing dark-faced Southdown rams n old native strain of sheep known as the Norfolk. The animals were described as wild, hardy, active, upstanding, -faced, horned, light-fleeced, and of faulty conformation, ighly prolific and with superior texture and quality of meat.

LY AMERICAN IMPORTATIONS:

Suffolk sheep were first brought to America in 1888. Within year, importations were made by M. B. Streeter, of Brook-

lyn, New York, and B. D. Sewell, of Frederickton, New Brunswick, Canada. It is to be noted, however, that no great numbers of this breed were imported until more recent years.

SUFFOLK CHARACTERISTICS:

The most commanding characteristic of the Suffolk breed is its very black face, ears, and legs. The head and ears are entirely free from wool, and the black hair extends to a line back of the base of the ears. There is no wool below the knees and hocks. The breed is also noted for its alertness and activity. Both rams and ewes are hornless, although the males frequently have scurs.

The size of the Suffolk approximates that of the Hampshire. Mature rams in good breeding condition weigh from 225 to 300 pounds and ewes from 160 to 225 pounds. Because of the lack of wool on the underline and lower legs, Suffolks are frequently mistaken as being leggy.

In general, the body conformation of the better Suffolks compares favorably with the best of the other mutton breeds. In comparison with the Hampshire, the Suffolk has a smaller, more refined head and is more smoothly laid-in at the shoulders. The most glaring deficiency of the Suffolk breed is its light shearing fleece, which frequently contains many black fibers. Perhaps the average flock of sheep of this breed will not produce more than 6 to 7 pounds of grease wool in a year's time. Suffolk ewes are very prolific and excellent milkers.

Because of its alert, active disposition, the breed is unsurpassed as a grazer and rustler.

The Tunis

Though the Tunis is a very old breed, it has never met with great favor among the sheep producers of this country.

ORIGIN AND NATIVE HOME:

The Tunis is a fat-tailed, medium-wool type sheep of Asiatic origin. It is said to have roamed the hills of Tunis and parts of Algeria, in northern Africa, prior to the Christian era. Further than this, little is known about the origin of the breed.

EARLY AMERICAN IMPORTATIONS:

The first importation of Tunis sheep consisted of a pair, ram and a ewe, which the United States consul at Tunis shipped to Pennsylvania in 1799. Subsequent purebred flocks were established in North Carolina, Georgia, and other southern states where they met with great favor and increased in number un-

ivil War, when they were practically exterminated. Follow-
ne Columbian Exposition in 1893, several flocks were re-
lished in the eastern and southern states, but in this coun-
ne breed has never been popular over any wide area.

S CHARACTERISTICS:

The Tunis is a medium-sized breed with a brownish face,
ılous ears, and no horns. The wool is white, brown, reddish,
mixed color and is coarse and harsh. The tail is distinctly
and fat, and in it energy is stored to carry the animal over
ds of famine. The Tunis is hardy, and the ewes are prolific
good mothers. Like the Dorset, Tunis ewes will mate at
st any season of the year. The mutton qualities of the lambs
nly fair.

G-WOOL BREEDS

The long-wool breeds, bred chiefly for mutton, are the largest
sheep. They originated in Great Britain in an era when
ıcers and consumers regarded with favor a large, coarse,
maturing sheep that produced long, coarse wool, and which
liberally fed would become very fat. These conditions gave
o such important breeds as the Cotswold, Leicester, Lincoln,
Romney. All of the long-wool breeds are large-framed, have
re bodies and are somewhat rangy in build with conspicu-
broad backs. As compared with the fleeces of the fine- or
um-wool breeds, those of the long-wool sheep are open,
e, and very long.

As their size would indicate, these breeds were developed
vel-lying country where feeds were abundant and could be
ned without too much travel.

At the present time, most purebred sheep of the long-wool
ds are considered too slow-maturing and big to satisfy the
nds of the lamb market. Moreover, their carcasses are quite
se and overlaid with fat. They are, however, of great value
ossbreeding to improve the weight of wool in other breeds,
crease the size of little sheep, and to increase the fattening
ties of some breeds. It is claimed that the long-wool breeds,
ially the Romney, will thrive in regions of excessive rainfall,
e long wool carries the water off the body and does not soak
as a more dense fleece will do. It is noteworthy, however,
most practical sheepmen caution against keeping sheep on
hy ground.

The Cotswold

Only limited numbers of Cotswold have ever existed in th country. At one time, rams of this breed were the most wide used of the long-wool breeds for crossing on range ewes, bu more recently they have been less important for this purpos Most of the present purebred Cotswold flocks are found in th north central states and in Oregon and Utah.



Fig. 210. A champion Cotswold ewe at Royal Winter Fair, Toron Canada. The most distinctive characteristics of the Cotswold breed are t natural wavy ringlets or curls in which the fleece hangs all over the b and the tuft of wool on the forehead. (Courtesy, Canadian Sheep Breede Association.)

ORIGIN AND NATIVE HOME:

The Cotswold breed is native to the Cotswold Hills of Glo cestershire, England. According to some historians, howeve the name of the breed is derived from the two words "cot and "wold"—the former meaning "sheep fold" and the lat meaning "open upland." Some claim that the Cotswold is t oldest of all breeds of sheep. At least it is very ancient, for early as the fourteenth century the wool of the Cotswold reg was widely and favorably known. It is also recorded that in 14 King Edward IV permitted choice sheep from this area to

ed to Spain. In the latter part of the eighteenth century, ative sheep of the Cotswold Hills were improved through se of outside blood, principally that of Leicesters.

LY AMERICAN IMPORTATIONS:

The first Cotswold, a ram, was imported by Christopher of Albany, New York, in 1832. Large numbers followed e next half-century.

SWOLD CHARACTERISTICS:

The Cotswold is very similar to the Lincoln and Leicester s, both with respect to its characteristics and its use in nt-day sheep production. Perhaps the most distinctive cteristic of the Cotswold breed is the natural wavy ringlets rls in which the fleece hangs all over the body and the tuft ol on the forehead. The wool is coarse and is 8 to 14 inches and usually grades "braid." The face and legs (below the and hocks) are white, although grayish specks and a bluish are common. The nostrils, lips, and the skin about the are black. Both rams and ewes are polled, although males ently have scurs.

The Cotswold is second only to the Lincoln in size. Mature in good breeding condition weigh 250 to 300 pounds and from 175 to 225 pounds. The type of the Cotswold is similar at already described for long-wool breeds in general. The icacy, milking qualities, and maternal instinct of the ewes onsidered superior to those of the other long-wool breeds, the exception of the Border Leicester.

Leicester

There are two strains of Leicester sheep: the English and Border. Although they are regarded as two distinct and ate breeds in England and some other countries, in the ed States they are merely thought of as two types of the breed, and registration of both types is in the same flock

GIN AND NATIVE HOME:

The native home of the Leicester breed of sheep is in the farming county of Leicester in central England. Although reed is very, very old, it remained for Robert Bakewell, of ley, to transform the ancient, ungainly, slow-maturing ster—which had been bred merely for size and a heavy e—into a compact, symmetrical, moderate-sized sheep pos- ng great aptitude to fatten. Bakewell's work in sheep breed-

ing began about 1760. His methods consisted of rigid selection toward an ideal which he had clearly in mind and close breeding to fix these desired characters. Success crowned his efforts. Although Bakewell's greatest achievement was with Leicester sheep, he was also a noted improver of Shire horses and Longhorn cattle.



Fig. 211. Leicester ewe, Champion, Royal Winter Fair. (Courtesy, Canadian Sheep Breeders' Association.)

The Border Leicesters had their origin in the border country of England and Scotland and were developed in the Cheviot Hills region from some of Robert Bakewell's English stock with perhaps some Cheviot blood added. For purposes of convenience, the characteristics of each type will be treated separately.

EARLY AMERICAN IMPORTATIONS:

It is not known in what year Leicester sheep were first introduced to America, except that it was before the Revolutionary War. George Washington, whose flock numbered eight

dred head at one time, used Leicester rams in improving flock at Mt. Vernon, and he also had some purebred ewes he same breed. Leicesters have had only limited popularity he United States, and today the breed is little known except an historical type.

GLISH LEICESTER CHARACTERISTICS:

In many respects, the English Leicester closely resembles Lincoln; the former, however, is the smaller of the two eds. Mature Leicester rams weigh from 225 to 250 pounds ewes from 175 to 225 pounds. The wool is usually finer than wool of the Lincoln or Cotswold, and generally the fleece gs from the body in smaller and tighter locks than it does he other two breeds. There is a small tuft of wool on the head, and there may be a very small amount of wool on the eks. The face and the lower legs (below the knees and hocks) covered with white hair, which may have a bluish tinge or k spots. The lips and nostrils are black. Both sexes are ed.

RDER LEICESTER CHARACTERISTICS:

The Border Leicester is slightly smaller and is more stylish active than the English Leicester. The Border type also is inguished from its cousin in that there is no wool on any t of the head; the ears are more erect and alert; the face leaner cut and more refined; and the wool is shorter, denser, has a purled or twisted tip. Border Leicester ewes are con-ered the more prolific and heavier milkers of the two types.

e Lincoln

Although comparatively few purebred Lincoln flocks ever e existed in the United States, the breed, through crossbreed- and in establishing other breeds, has been a powerful influ-e in molding the sheep industry of the nation.

Lincoln sheep have made an important contribution to the rld's sheep industry.

At the present time, the few Lincoln flocks of the United tes are confined mostly to the northern and northwestern tes.

IGIN AND NATIVE HOME:

The Lincoln originated in Lincolnshire, a fertile area on the tern coast of England and bordering the North Sea. This ed is still the principal one in this shire, where it is known

as the general-utility sheep. Lincolns are a very old, large, coarse, slow-maturing sheep with heavy fleeces. The breed has been produced in Lincolnshire for many years. It is reported that much improvement had been made in the breed as early as 1863 by the introduction of Leicester blood and by selection.



Fig. 212. A champion Lincoln ram at the Chicago International and many other fairs. Shown by Crandell's Prize Stock Farm, Ithaca, Michigan. This ram weighed 301 pounds and sheared a 27-pound fleece. The Lincoln is reputed to be the heaviest breed of sheep in the world. (Courtesy National Lincoln Sheep Association.)

EARLY AMERICAN IMPORTATIONS:

Some of the old type Lincolns are said to have been imported to America shortly after the Revolutionary War, but the breed was not important here until much later. The first of the improved Lincolns, a shipment of ten head, were brought into Massachusetts in 1825. Several other importations followed shortly afterwards.

LINCOLN CHARACTERISTICS:

The most impressive characteristic of the Lincoln is its great size. It is reputed to be the heaviest breed of sheep in the world. Mature rams weigh 250 to 350 pounds or more and ewes from 225 to 250 pounds. The body form is typical of the long-wool breeds. In addition to being the largest breed of sheep

Lincoln produces the heaviest fleece of any mutton breed. ough light in yolk and open, the fleece weights range from 20 pounds after a year's growth, with staple 10 to 14 inches ngth. The face, ears, and legs (below the knees and some- below the hocks) are covered with white hair, although spots may be present. Dark nostrils, lips, and feet are erred. Both sexes are polled. Lincoln sheep are usually slug- slow-maturing, frequently patchy when fattened, and only age from the standpoint of prolificacy and milking ability.

Romney (also known as Romney Marsh or Kent Sheep)

Claims are made that the Romney breed of sheep is less eptible than other breeds to foot rot and liver flukes, two p ailments common to wet areas. Although these claims have r been proved or disproved, the breed must possess these or r virtues, for Romney sheep are found in nearly every coun- of the world and frequently in areas of heavy rainfall.

GIN AND NATIVE HOME:

The native sheep of the Romney Marsh region in England rangy in form, slow-maturing, and coarse-wooled, but they essed a hardy constitution. Beginning in the early part of the teenth century, they were improved by crossing with Leices- ams and by careful selection of the offspring.

RLY AMERICAN IMPORTATIONS:

The first importation of Romneys to America was made by iam Riddell and Sons, of Monmouth, Oregon, in 1904. Other ortations followed, but no great numbers have ever been blished in this country.

MNEY CHARACTERISTICS:

In comparison with the other long-wool breeds, the Romney ds on shorter legs and is more rugged; but it is lighter in ght. Mature rams weigh from 200 to 250 pounds and ewes 175 to 200 pounds. Although the Romney is classed as a -wool breed, the Romney fleece—in comparison with the produced by Lincolns, Leicesters and Cotswolds is less open. staple is shorter and finer, and there is less luster. Romney ranges in grade from braid to quarter-blood, with average rly clips of 10 to 12 pounds expected.

In general, there is a tuft of wool on the forehead, and the eks are covered with short fibers. The balance of the face the legs below the knees and hocks are covered with white (although wool may extend below the hocks). The hoofs,

nostrils, and lips are dark-colored. Both sexes are polled. Romney ewes are not noted for prolificacy. In this country, the largest numbers of this breed are located in Oregon, in which state the American Romney Breeders Association has its headquarters.



Fig. 213. A Romney ram. Shorter legged and more rugged than the other long-wool breeds, the Romney is reputed to thrive in areas of heavy rainfall and on low, wet land.

CROSSBRED WOOL BREEDS

The crossbred breeds, which are descended from a long-wool X fine-wool foundation, produce medium-fine wool and are therefore often classed with the medium-wool breeds. In general, however, the crossbred wool breeds are better adapted to the western range than are their respective parent stocks or any of the medium-wool breeds. Under range conditions, they produce better market lambs and heavier fleeces than the Rambouillet, and they are more active and have superior herding tendencies in comparison with either the long-wool or medium-wool breeds.

For many years, commercial ranchers have been crossing long-wool rams on grade fine-wool ewes in an effort to secure larger ewes that would yield more wool and produce heavier and superior market lambs. The results were often variable. Sometimes the mutton qualities would be improved but the wool would be coarse; whereas at other times the wool yield would be greater, but the mutton qualities would be disappointing.

Despite the lack of uniformity, most commercial sheepmen
he West preferred this method to the system of alternating
ne use of black-faced and fine-wool rams. Topping the band
black-faced rams produced an excellent market lamb; but
use of lack of the herding instinct, poor fleeces, and other
iencies, the resulting crossbred ewe lambs were not suitable
flock replacements. In order to get desirable replacements,
efore, fine-wool rams had to be used at intervals, with the
lt that the wether lambs of this breeding did not meet
ket demands. Thus the need was for a type of sheep which
ld eliminate the ram problem that invariably plagued sheep-
in the alternate use of black-faced and fine-wool rams and
h would produce lambs suitable for either market or replace-
t purposes. Such was the need, and out of this need arose
Columbia, Corriedale, Panama, and Romeldale breeds of
p—all descended from long-wool X fine-wool foundations.

Columbia

The Columbia breed is strictly an American creation. In
r of its being the first breed of sheep developed in this
ntry, it was appropriately given the name that it now bears.

GIN AND NATIVE HOME:

The breeding program, out of which the Columbia eventually
ved, was initiated in 1912 by the Bureau of Animal Industry
he King Ranch at Laramie, Wyoming. Five years later, in
7, the animals were transferred to the newly established U. S.
ep Experiment Station at Dubois, Idaho. The Columbia breed
ased on a crossbred foundation of Lincoln rams on Rambouil-
ewes. From the very beginning, breeding animals were select-
olely on the basis of utility value, with no breed fancy points
hinder progress.

LUMBIA CHARACTERISTICS:

The Columbia breed is said to be larger than the other
ssbred breeds and therefore is adapted for use on the better
ges of the West, such as those of northwestern United States.
en in range condition, mature rams weigh from 225 to 275
nds and ewes from 125 to 190 pounds. Fitted rams may weigh
n 300 to 350 pounds. Under range conditions, Columbia ewes
produce a yearly clip of 11 to 13 pounds, grading three-
ths and quarter-blood. The ewes are reasonably prolific and
d mothers, and the lambs are of acceptable market type.
ny specimens of the breed are deficient in spring of forerib

and are sloping in the rump and lacking in fullness of the rear quarters. Many good sheepmen also would prefer to shorten the legs, although it is fully realized that reasonable length of leg is necessary in a range sheep. The Columbia, however, is a relatively new breed, and these deficiencies can be improved with further selection.



Fig. 214. Columbia ram owned by E. H. Thompson, Milan, Missouri. The Columbia, which is an American creation, is an open-, white-faced breed. It was developed primarily for the better ranges of the West, but its distribution is rapidly becoming nation-wide. (Courtesy, The Sheepman Magazine.)

The Columbia is an open-faced breed with no tendency to wool blindness. The face and legs are covered with white hair. Both sexes are polled. The breed possesses a good herding instinct. Although numbers are limited, the Columbia breed of sheep is highly esteemed on the ranges of the West.

The Columbia registry association is unique among sheep registry associations in requiring inspection for merit before admitting animals for registration.

The Corriedale

The Corriedale is the oldest of all of the so-called crossbred wool breeds. It represents an effort to combine into one breed

e of the features of both the Merino and Lincoln, neither
vhich in the opinion of some breeders possessed the utility
ities needed for sheep production in New Zealand and Aus-
a.

GIN AND NATIVE HOME:

The Corriedale originated in New Zealand in about 1880. In
country, where sheep raising is a very important industry,
mutton and wool production are sought. Thus the develop-
t of the Corriedale was an effort to develop a dual-purpose
of sheep. Lincoln and Leicester rams were crossed on Meri-
wes. By inbreeding and careful selection, a uniform type was
blished that produced a good balance of mutton and wool.

These sheep were named after the Corriedale estate of
go, New Zealand, where the experimental crossbreeding was
e.

From its long-wool ancestors, the Corriedale inherited a good
ton conformation, and from its Merino parentage it derived
nse fleece of good quality.



Fig. 215. Grand Champion Corriedale ram, Chicago International, 1948. ed by Clyde Gebbardt, Salem, Wisconsin. Corriedales are outstanding heir efficiency, generally producing more pounds of lamb and wool per d of body weight than other range breeds.) (Courtesy, American Cor-ale Association, Inc.)

EARLY AMERICAN IMPORTATIONS:

The Corriedale was first brought to the United States by the Bureau of Animal Industry, which imported fifty-three ewes and ten rams to Wyoming in the year 1914. The Bureau tested the use of these sheep in the Rocky Mountain region and found them well adapted to the range area.

CORRIEDALE CHARACTERISTICS:

In general, Corriedales stand closer to the ground than Columbias, but they are smaller. Mature rams in good condition weigh 185 to 250 pounds and ewes from 125 to 185 pounds. On the average, animals of this breed shear 10 to 12 pounds of grease wool from each year's growth. The wool usually grades three-eighths blood and is noted for exceptional length, brightness, softness, and a very distinct crimp. Corriedales are outstanding for their efficiency, generally producing more pounds of lamb and wool per pound of body weight than other range breeds.

The face, ears, and legs are covered with white hair, although black spots are sometimes present (brown spots are considered a defect). Wool blindness is discriminated against. Both sexes are polled, although rams sometimes have horns. The ewes are considered fair in prolificacy and milking ability. Corriedales herd well. From the standpoint of range production, many practical sheepmen consider the Corriedale too small and lacking in bone and ruggedness.

The Panama

The Panama closely resembles the Columbia. This is as one would expect, as both breeds have a similar foundation.

ORIGIN AND NATIVE HOME:

The foundation of the Panama breed was started in 1912 by Laidlaw and Brockie of Muldoon, Idaho. Rambouillet rams were crossed on Lincoln ewes. These are the same two breeds that were used in developing the Columbia. The only ancestral difference between the Panama and Columbia is that in the case of the Columbia breed the sexes were reversed; that is, Lincoln rams were crossed on Rambouillet ewes. After Laidlaw and Brockie had made the initial cross of Rambouillet rams on Lincoln ewes, the flock was closed and bred and selected from within.

PANAMA CHARACTERISTICS:

As would be expected, the Panama closely resembles the Columbia. In general, it appears to have been selected a little



Fig. 216. Yearling Panama ram, bred and owned by the University of ho. The Panama is a white, open-faced breed—closely resembling the umbia. (Courtesy, C. W. Hickman, University of Idaho.)

re for mutton conformation and with less stress on size. To e, no breed registry association has been organized.

e Romeldale

Although the breed is new and numbers are few, the Romel-e has given a good account of itself where used.

IGIN AND NATIVE HOME:

This relatively new breed of crossbred wool-type sheep was veloped by A. T. Spencer, Spencer Ranch Company, Woodland, lifornia. At the present time, there is no national registry sociation; private flock books are kept by the founder of the eed.

The Romeldale is based on a crossbred foundation, resulting m crossing eleven select Australian and New Zealand Romney rsh rams on superior Rambouillet ewes. Subsequently the eed has been bred entirely from within, and rigid culling has en practiced. The expressed object of Spencer's program is establish a breed adapted to wet marshy land, to the pasturing alfalfa and other heavy forage crops, and to twice-a-year earing.

ROMELDALE CHARACTERISTICS:

The Romeldale is a white-faced sheep, somewhat resembling the Corriedale and Columbia; but it is larger, heavier boned, and more rugged than the former and lower set and more blocky than the latter. As would be expected from its crossbred foundation, its fleece is intermediate between the medium- and long-wool type. Selection has been for a half-blood fleece with a long staple.

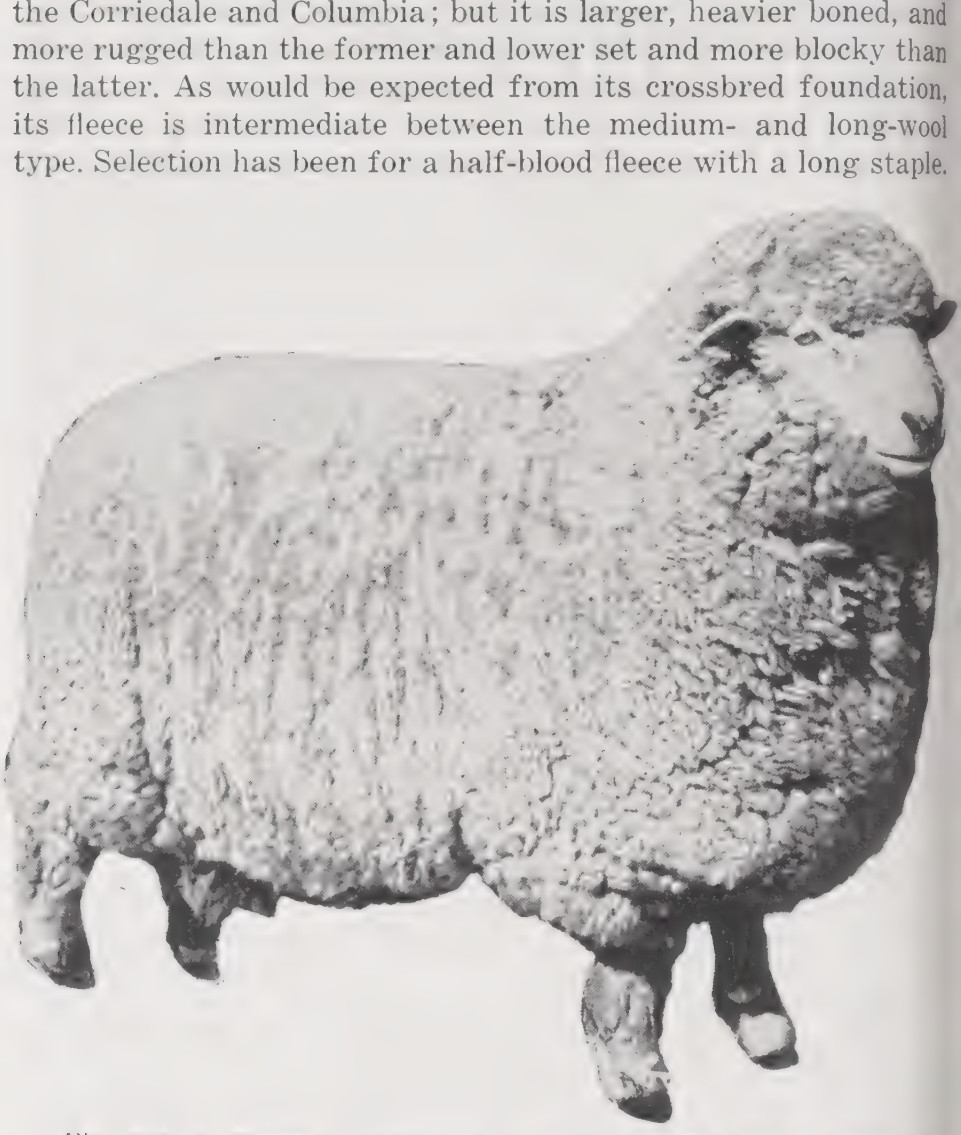


Fig. 217. A Champion Romeldale ram at the California Grand National, shown by A. T. Spencer, Woodland, California. The Romeldale is a low-set, rugged, white-faced sheep. (Courtesy, A. T. Spencer, Spencer Ranch Company, Woodland, California.)

THE CARPET-WOOL BREED

Wools used in the manufacture of carpets and rugs in the United States are imported from Asia Minor, China, India, South America, and other countries where the native sheep possess a coarse, wiry, tough, fleece. Most American wools are too fine to be used in carpets. If so used, they would mat down and wear

ry rapidly. Carpet wools are quite variable, ranging from 1 to inches in length and from 15 to 70 microns in diameter. In dition, carpet wools show a tremendous range of lustre, ength, crimp, and resilience. Although several foreign breeds sheep produce carpet-wools, the only carpet-wool breeds known most people in this country are the Black-Faced Highland and e Karakul. As the latter breed is primarily kept for fur produc- n (the production of carpet-wool being somewhat incidental m mature breeding stock), the Karakul is herein discussed a fur sheep.

e Black-Faced Highland

The Black-Faced Highland is one of the hardiest breeds of eep. It is seldom provided with shelter or supplemental feed the highland country of its origin.

IGIN AND NATIVE HOME:

As the name implies, the breed originated in the highland ntry of Scotland. Further than this, little is known about the velopment of this hardy and picturesque breed.

RLY AMERICAN IMPORTATIONS:

The breed was first imported into New York State in 1861. ly a few importations followed so that the breed is of very nor importance in this country.

ACK-FACED HIGHLAND CHARACTERISTICS:

Like all the breeds of Scotch origin, the appearance of the ack-Faced Highland is striking. Both sexes have horns. The ns' horns are heavy, long, and spiraled. The ewes' horns are aller. The face and legs are free from wool and are black or ttled in color.

The fleece is impressive but unimproved when judged by our tablished criteria of quality. It consists of a long, coarse outer- at and a finer innercoat, which together form a maximum of otection against inclement weather, such as exists in the Scot- h highlands. The wool is of carpet grade.

These sheep are small, rugged, active, and adept at grazing er rough terrain. Rams weigh about 150 pounds and ewes 5 pounds.

HE FUR SHEEP BREED

New processes have resulted in the use for fur of pelts tained from many breeds of sheep. Except for the Karakul, wever, all the other breeds of sheep are still kept primarily

for lamb and wool production; and any fur production is secondary.

The Karakul

Karakul sheep are bred primarily because of the suitability of the lamb pelts for fur production. Four million lambskins are imported annually into the United States, and the annual production in this country is about eight thousand skins. The majority of Karakul lambskins are produced in Bokhara (U. S. S. R.), Afghanistan (Herat), Southwest Africa, Bessarabia, Shiraz (Iran), Baghdad and Salzfelle (Iraq), and India. The best-grade lambskins come from Bokhara, the country in which the Karakul breed originated.



Fig. 218. A Broadtail pelt properly dried (note shape) and cleaned for shipment and sale. At the present time, the annual United States production of lambskins only totals about 8,000, but each year some 4,000,000 lambskins are imported. (Courtesy, Lowry Hagerman, Santa Fe, New Mexico.)

ORIGIN AND NATIVE HOME:

The Karakul breed of sheep is native to south central Asia, in the country of Bokhara (U. S. S. R.). The name Karakul is taken from the village of Kara Kul in Bokhara, meaning Black Lake. Bokhara has a high elevation, mostly in excess of eight thousand feet, very little rainfall, and scant vegetation. Under these conditions, only very hardy sheep could survive. Although the origin of the breed is obscure, it is known that central and western Asia have produced for centuries both fat-rump and fat-tail sheep. The Karakul belongs to the latter group.

ARLY AMERICAN IMPORTATIONS:

Three importations of Karakuls have been made to the ited States directly from Bokhara, the first in 1909. A total thirty-four rams and thirty-three ewes have been brought o this country.



Fig. 219. A yearling Karakul ram. Karakul lambs are eminently apted for fur production, but the wool of mature animals is of low market ality—grading carpet wool—and the breed is of poor mutton type. (Courtesy, Lowry Hagerman, Santa Fe, New Mexico.)

ARAKUL CHARACTERISTICS:

In order of their value, the pelts are classified as follows:

1. **Broadtail.**—This is the most valuable, although its production is comparatively small. It is produced from prematurely rn or stillborn lambs, and in some instances from those killed ithin a few hours after birth. The hair is undeveloped, grows different directions, and reflects light, giving the pelt its noire" appearance ("moire" means watery design).

Such premature deaths are not forced but are the result of cidents, such as abortions.

2. **Persian Lamb.**—This type of fur is next in value and mes from Karakul lambs three to ten days old. It has a tight

lustrous curl that must be watched carefully from the time the lamb is born, for the curl is likely to open rapidly after the fifth day; and while the value of the pelt increases with size, it is essential that the curl remain tight.

3. **Caracul.**—Caracul, spelled with a "C," is a trade name given to the lustrous open-type of fur that shows a wavy moire pattern free from close curls.

Caracul skins are light in weight and are best if removed when lambs are not more than two weeks old. But this type of pelt does not deteriorate so rapidly with growth as do those of either the broadtail or Persian lamb types. Caracul is the least valuable of the three types of pelts.

Within each of these three groups, there are different grades of pelts, depending upon quality, tightness of curl, luster, pattern, color, and general appearance. As would be expected, the price varies with the type and quality of the fur and with the supply and demand.

As is true in making any fur garment when the smaller furs are involved, large numbers of pelts are required for proper matching. For this reason, it is often difficult to sell small numbers of pelts to advantage.

Up to the present time, only a relatively few Karakul pelts have been produced in this country. For the most part, the lambs have been raised and sold to new breeders interested in establishing flocks.

Contrary to the opinion of many amateurs, the fleece of the mature Karakul is of low market quality and usually is sharply discounted in price. It grades as carpet wool. Although most lambs are black at birth, the coat at about a year of age turns brownish or gray in color.

The Karakul breed is of poor mutton type. The body is angular, tall, and long. Mature rams weigh from 175 to 225 pounds and ewes from 135 to 160 pounds. The face and legs are black or brown in color. The ears are drooping. The rams have dark, ripply horns turned outward in spirals, but the ewes are hornless. The Karakul is a fat-tailed sheep; the heavy fat accumulation frequently causes the tail to weigh 5 to 6 pounds.

NEW AND LESS WIDELY DISTRIBUTED BREEDS

In addition to the breeds already discussed, brief mention will be made of the following new and minor breeds: Montadale, Ryeland, Tailless or "No Tail" Sheep, and Targhee.

he Ryeland

The Ryeland breed originated in Herefordshire, England. size and body conformation, animals of this breed resemble e Shropshire. They may be easily distinguished, however, cause their face and legs are covered with white hair. A few veland sheep were introduced to Canada in 1930, but they have t met with favor in the United States.



Fig. 220. Tailless or "no tail" sheep, developed by South Dakota State ollege. If this program is successful, as it now gives promise of being, it ill eliminate the necessity of docking lambs of this breed. (Courtesy, outh Dakota State College.)

he Tailless or "No Tail" Sheep

Using Siberian fat-rumped sheep with very short or no tails s foundation stock, the South Dakota Experiment Station, since 914, has been engaged in a breeding program which, if success- l, will eliminate the necessity of docking lambs. Considerable umbers of tailless of "no tail" sheep have been produced, but rogress has been slow and tedious because the tailless charac- eristic is not dominant in crossing. Selection is now being direct- d toward improving the mutton and fleece qualities of the strain.

The Targhee

Since 1926, the U. S. Department of Agriculture Sheep Experiment Station, Dubois, Idaho, has been interbreeding a strain of sheep produced by crossing Rambouillet rams on Lincoln-Rambouillet and Lincoln-Rambouillet-Corriedale ewes. This performance selected strain, which is predominately of Rambouillet extraction is known as the Targhee. It is a white-faced, polled



Fig. 221. Targhee ram, bred and owned by the U. S. Sheep Experiment Station, Dubois, Idaho. The Targhee is a white-faced, polled breed of intermediate size developed primarily for use on the intermediate ranges of the West. (Courtesy, U. S. Sheep Experiment Station, Dubois, Idaho.)

breed of intermediate size. Mature rams weigh about 200 pounds and ewes 130 pounds. The Targhee is clean faced, free from wrinkles, and has a fleece of half-blood quality of about 3-inch staple. The annual clip is about 11 pounds per animal. This new breed appears to be very promising for use on the intermediate ranges of the West.

The Montadale

The Montadale breed of sheep was developed by E. H. Mattingly, of St. Louis, Missouri. Although Mr. Mattingly first began crossbreeding in 1914 in an effort to produce what he vizualized

a superior type of sheep, the foundation of the present Monta-
le breed was not laid until 1932. At that time a Columbia ram
as crossed on Cheviot ewes. In subsequent years, the sire and
m of these breeds was reversed; that is, a Cheviot ram was
ossed on Columbia ewes. The latter cross has been used most
tensively and is recognized by the Montadale Association as
e foundation cross.

The Montadale is of good mutton type. It possesses white
ce and legs that are free from wool. Mature ewes produce an
nual wool clip of 10 to 12 pounds that averages three-eighths
ood. The breed appears to be gaining favor rapidly.

CHAPTER XIX

ESTABLISHING THE FLOCK; SELECTING AND JUDGING SHEEP

Whether a large range operation or a small farm flock is being established or maintained, consideration must be given to certain factors, if the venture is to be successful. In the final analysis, sheep are maintained for the production of market lambs and wool. This means that each individual in the flock should possess those characteristics making for maximum and efficient production of these two products. Furthermore, if progress is to be made in the breeding program, each succeeding generation must represent an improvement over the parent stock.

FACTORS TO CONSIDER IN ESTABLISHING THE FLOCK

The factors to consider in establishing a flock of sheep are not unlike those that the stockman must face in establishing a herd of cattle, hogs, or horses. They are, however, somewhat more confused because (1) two major products are involved—lamb and wool—instead of one; and (2) there are more breeds from which to select, and the practice of crossbreeding is more prevalent.

Purebreds, Crossbreds, or Grades

Generally speaking, only the experienced breeder should undertake the production of purebreds with the intent of eventually furnishing foundation or replacement stock to other purebred breeders or purebred rams to the commercial producer. Unless prices are unusually favorable, the beginner should start with crossbred or grade ewes and a purebred ram. The vast majority of range operators, most of whom are capable sheep specialists, elect to keep bands of high-grade ewes that are mated to purebred rams.

Native or Western Ewes

Native ewes are those produced outside of the western range area, and they show a predominance of mutton-type breeding. Western ewes are those produced in the range area, and they either show a predominance of fine-wool breeding or represent fine-wool X long-wool crossbred types.

In starting a farm flock, the question often arises as to ether native or western ewes should be purchased. Both types ewes are found in flocks throughout the country and may l be considered by the beginner. In general, western ewes more uniform, smaller in size, less costly, and less likely be infested with parasites. On the other hand, the native es are larger, and they produce a larger lamb. If they are ght locally, a saving in price may be effected. In purchasing ive ewes, however, the buyer should make very certain that is not obtaining the cull ewes (shy breeders and ewes with ound udders or other defects) from one or several flocks. om this standpoint, the purchase of yearlings affords the best tection.

For range operations, where a large number of animals are be handled in one or more bands, grade ewes of fine-wool eding or ewes of the fine-wool X long-wool crossbred type essential.

ection of the Breed

Within certain limitations, preference is usually the decid- factor in the selection of a breed. As already noted, however, ere is good reason that most commercial bands of the West ould carry considerable fine-wool breeding (chiefly because the herding instinct in the animals). Except for this situation, eep producers of this country have given little consideration possible special-area adaptations of the different breeds. Eng- sheep breeders, on the other hand, have long contended that ne breeds are peculiarly adapted to certain conditions. This viction springs from the fact that the several English breeds re developed in different geographical areas, each of which d different climatic, soil, and crop conditions.

According to English breeders, the small and more-active eeds of sheep that were developed in the hill country of Eng- nd are not adapted to the lowland region, whereas the large d more-sluggish breeds developed in the fertile lowland areas l not thrive on the uplands. Moreover, the Romney breed is d to thrive better than any other breed in marsh areas similar those of its native home in southern England.

Unfortunately, there is little experimental work to either bstantiate or refute these contentions relative to environmen- adaptations of breeds. It is interesting to note, however, that the U. S. D. A. Experiment Station at Dubois, Idaho, two

crossbred breeds of sheep are being developed—the larger Columbias for the lush ranges of the West and the smaller Targhees for the average ranges. It is also a well-known fact that for the production of hothouse lambs, the ewes must breed out of season and milk well. This limits the production of hothouse lambs to ewes of Dorset, Tunis, Rambouillet or Merino breeding.

In so large and variable a country as the United States, it would appear quite probable that some breeds would be better adapted to certain conditions than others. It is also quite likely that rather wide differences in environmental adaptations may exist within breeds. Perhaps there is need for experimental work to determine these differences, if any, but it must be recognized that (1) breed preference is, and should remain, a powerful factor in the selection of a breed, and (2) it is difficult, if not impossible, to obtain a representative cross-section of a widely disseminated breed of sheep for experimental study.

Size of the Flock or Band

The unit of sheep management varies all the way from a small farm flock consisting of a few head to a large range band with as many as 3,500 head. Usually, the farm flock is merely a part of a diversified type of farm enterprise, whereas several range bands may constitute a highly specialized type of operation with little or no diversification.

Small farm flocks are variable in size, ranging from a few head to as many as three hundred to five hundred. In determining the size of the farm flock, it is to be noted that the labor and equipment cost, except at lambing time, differs very little whether the flock numbers twelve or fifty. The smaller flock will require the services of one ram and practically the same amount of fencing to provide rotation of pastures or suitable corrals away from dogs. Furthermore, fewer sheep are much more likely to receive the neglect often accorded a minor enterprise.

On the other hand, the beginner can acquire valuable practical experience with a very small flock without subjecting a large flock to the possible hazards that frequently accompany inexperience. In range operations, the size of the band varies somewhat according to the method of management, the general character of the country, and the season of the year. The number of bands run by a given operator is usually determined by the amount of range and capital available.

me To Start

Late summer, after the lambs have been weaned and before e ewes are bred, is usually the best time in which to start into e sheep business. At this season of the year, it is generally ssible to buy some of the surplus ewes from neighboring farm- s or ranchers or to obtain a wide selection of ewes from the rminal markets. Ewes can usually be purchased at reasonable ices at this period, and for the beginner there is a period of luable training prior to lambing time. Furthermore, there is ually an abundance of meadows, grain stubble land, and other rage available on the farm or ranch that will make it possible get the ewes in good thrifty condition prior to breeding time. ien, too, the purchase of a uniform flock of ewes makes pos- ble the intelligent selection of the ram and the production of mbs with uniformity of type and quality.

iiformity

In order to produce uniform market lambs and wool, it is st desirable that the ewe flock selected be uniform—preferably om the standpoint of breeding, size, body conformation, and ece grade and quality. Such uniformity is of decided advantage the marketing of products at premium prices. Also, the con- uctive sheepman is able to select more wisely a ram or rams r most successful mating with a uniform flock or band of ewes.

ealth

All ewes selected should be in a thrifty, vigorous condition. ey should have every appearance of a life of usefulness ahead them and give every evidence of being capable of producing good fleece and raising strong, healthy lambs. Animals showing rk blue skins, paleness or lack of coloring in the lining of the se and eyelids, listlessness or a lack of vigor, and a general n-down condition should be regarded with suspicion.

ge

The vast majority of sheepmen prefer to establish a flock acquiring yearling ewes that are bred to lamb when approxi- ately twenty-four months of age. When it can be made certain at culls are not being secured, however, older ewes are fre- ently the best buy. Sometimes it is to the advantage of a farmer secure range ewes that have one to two years of usefulness left, ovided that they are placed under conditions where (1) less aveling is required, (2) the pastures are more abundant, and) more attention is given to winter feed.

Soundness of Udder

In selecting ewes, particular attention should be given to the udder and teats. The udder should be soft and pliable and the teats normal. Ewes having hard or pendulous udders, teats that have been removed through careless shearing, or meaty or abnormally large teats should be rejected.

Size

There is great variation in the size of the different breeds of sheep, extending all the way from the small, refined Southdowns to the large, ponderous Lincolns. The rank and file of commercial sheep producers in this country prefer an animal with considerable size, because, based on experience, it has been found that such animals are more profitable from the standpoint of the net receipts derived from the usual combination of lamb and wool production. This is due to the fact that, in general, the cost of handling sheep is on a per-head rather than on a per-pound basis, and our markets are not sufficiently discriminating in the purchase of lamb and wool to warrant any great sacrifice in quantity in favor of quality production. On the other hand, an exception exists when a premium is paid for early-maturing, high-quality lambs, such as in hothouse lamb production. Under the latter conditions, it is preferable to use early-maturing, mutton-type rams on medium-sized ewes. Also, where feed is sparse and sheep are run with a minimum of care, smaller sheep may be preferable, as they often are more efficient than larger animals.

In an effort to secure more size on the lush ranges of northwestern United States, many commercial operators are keeping crossbred type ewes, based on long-wool X fine-wool crosses. Moreover, larger grade ewes of Rambouillet extraction have always been more popular on the western ranges than the smaller ewes of Merino breeding.

Price

The price of breeding sheep must be based upon the projected price of the products of production—lamb and wool. Although it is usually sound business to pay a premium for quality foundation stock, it must be remembered that the ultimate objective of all sheep production is profitable market-lamb and wool production; thus the price should be governed accordingly.

LECTION AND ITS BASES

The criteria used in selecting an individual or group of sheep lambs will vary according to the use for which the animal animals are intended. In general, commercial farmers or achers select sheep or lambs for the following purposes: (1) eeding sheep, with market lambs as the primary objective; breeding sheep, with wool production as the chief objective; feeder lambs for further fattening; or (4) fat lambs to send the market. Thus, where market-lamb production is the main sideration, primary attention is given to those factors that l result in the production of a heavy, fat lamb of acceptable e and grade. When sheep are maintained chiefly for wool duction, the clean weight and quality of fleece are of para-unt importance. Feeder lambs are selected on the basis of irable type and quality, health and thrift, and projected gains l finish with feeding. Fat lambs are selected out for the mar-, using finish, conformation, and quality as the criteria in ermining value. The experienced operator can determine the gree of fatness of sheep by touch, by rapidly applying the palm the hand to the animals being examined as they file through utting chute.

Purebred breeders may add certain breed fancy points and hly prized pedigrees to the above considerations, and market cialists find it necessary to add other considerations in arriv- at the rather imposing list of market classes and grades of eep. It is not intended, therefore, that the amateur may be-ne proficient as a sheep judge through merely reading about subject. There is no shortcut or substitute for long years of ient practice.

In establishing a new flock or improving an old one, however, re are four bases of selection, namely, (1) selection based on e or individuality, (2) selection based on pedigree, (3) selec-n based on show-ring winnings, and (4) selection based on duction testing.

ection Based On Type or Individuality

A vast majority of sheep, both purebred and commercial mals, are selected on the basis of type or individuality. In lim-l instances, three additional criteria may be available and oked effectively, namely, pedigree, show-ring, and production ection. Although production selection offers a new and modern proach to animal improvement and pedigree selection may be

a valuable guide in certain instances, perhaps for many years to come selection will continue to be based largely on individuality. Without doubt, however, the progressive sheep producer of the future will at least make increased use of production-tested rams. Despite the greater certainty and more rapid progress afforded through selection based on production, it is well to note in retrospect that we have traveled a long way in sheep improvement—from the rather poor mutton type and average two-pound clips of the sheep characteristic of General Washington's time to the modern sheep of today.

The judging of sheep—their selection based on individuality—differs materially from the judging of cattle, hogs, or horses because of the presence of the fleece. Not only must an additional characteristic of economic importance be considered, but the presence of the fleece makes it more difficult to determine the body type. This is especially true when the animal has been subjected to the blocking art of a clever shepherd, but the problem exists whenever there is any appreciable wool growth. Even though complete production records are not available, the progressive sheepman can arrive at sufficient evaluation to enable him to (1) cull the dry ewes, (2) remove wool-blind ewes and rams, and (3) sort out the light-fleeced animals by the "touch method" or according to actual fleece weights. This type of selection directly affects the income, even though it may not be very important genetically.

Selection Based On Pedigree

Without doubt, less attention is paid to pedigree selection and family names in sheep than in any other class of farm animals. It is a rare occurence, indeed, to find a commercial sheepman who has any concern about the ancestry of the rams that he is contemplating purchasing. Although most purebred breeders are interested in the pedigree of stud rams, there is comparatively little interest in the ancestry of the flock ewes. In some respects, this relative lack of interest in pedigrees on the part of sheep breeders is fortunate, for breeding programs have not been subjected to the hazards of worshipping family names or of selecting a breeding animal chiefly because its ancestry traces to some noted ancestor many generations removed. On the other hand, it must be recognized that fancy pedigrees may have sales value from the standpoint of the purebred breeder.

ection Based On Show-Ring Winnings

There can be no question that the great livestock shows of land have been a profound influence in establishing type in different breeds of sheep. It might well be added, however, t when utilitarian considerations have been ignored, their uence has not always been for the good. A prime example the latter point is the face covering that has been bred into tain of the mutton breeds of sheep. This has caused the affect- breeds to diminish in importance and numbers, because, ough sad experience, the practical operator has found that es subject to wool blindness produce less market lamb and ol. Utility value, therefore, should always come first and breed cy points, second.

Winning rams and ewes and their progeny are usually in at demand, with the result that they generally bring premium es. Provided that the type has been established wisely and based on utilitarian considerations, the purebred breeder may l it desirable and profitable to select some animals on the basis show-ring winnings.

ection Based On Production Testing

The relative merits of (1) individual merit testing and (2) geny testing have been presented in Chapter II; and traits importance in testing sheep and suggested records are given Chapter XXI. At this point, it may be well to emphasize that importance attached to each trait will vary in different areas. example, in southwestern United States, where wool produc- n is relatively more important than lamb production, greater ess should be placed upon selecting animals whose progeny sess the maximum in fleece weight and quality. On the other nd, in those areas where feed is more abundant and approxi- tely two-thirds of the annual income is derived from the sale lamb, evaluations should be based largely on the market ight, type, and finish of the offspring.

Production selection should be given greater emphasis in mal improvement, for, in most instances, it is production f which individuality or type is merely a part—that produces income. Also, again and again, it should be emphasized that ection based on either individual merit testing or progeny test- is far more accurate than any other method of selection.

FLOCK IMPROVEMENT THROUGH SELECTION

Once the flock or band has been established, improvement can be obtained only through constant, rigid culling and careful selection of replacements. Such procedure makes the flock more profitable from the standpoint of quantity and quality lamb production and affords a means of accomplishing genetic gain in the next generation.

JUDGING SHEEP

Since the general requisites in judging, which are similar with all classes of livestock, are fully covered in Chapter XI, repetition at this point is not necessary.

The judging of sheep differs from the judging of cattle or swine in that two products of economic importance are involved instead of one. That is, in addition to meat production, wool is a valuable product. The situation is made more trying because body conformation is often difficult to determine because of the wool under which it is hidden. The latter situation is accentuated when sheep are subjected to the art of blocking of a clever shepherd.

Parts of a Sheep

The first step in preparation for judging sheep consists of mastering the language that describes and locates the different parts of the animal. Figure 222 sets forth this information.

Ideal Mutton-Type and Conformation

The second requisite of a successful judge of any class of livestock is that he have clearly in mind an ideal or standard of perfection. Thus, the sheepman, regardless of whether he is producing purebred or commercial animals or whether he is a farm-flock or range-band operator, should have a type or ideal in mind and make his selections accordingly. For the mutton-type breeds, and when the production of market lambs is the primary objective, this ideal means plenty of size; good width, depth and compactness of body; a short, wide head with large, clear eyes; a short, thick neck; a wide, deep chest; good spring of rib; lowness in both fore and rear flank; a wide, strong back; width and thickness through the loin; length and levelness over the rump; a large leg of mutton; plenty of bone on which to stand; straight legs and closeness to the ground; and a fleece of acceptable weight and quality and a pink skin.

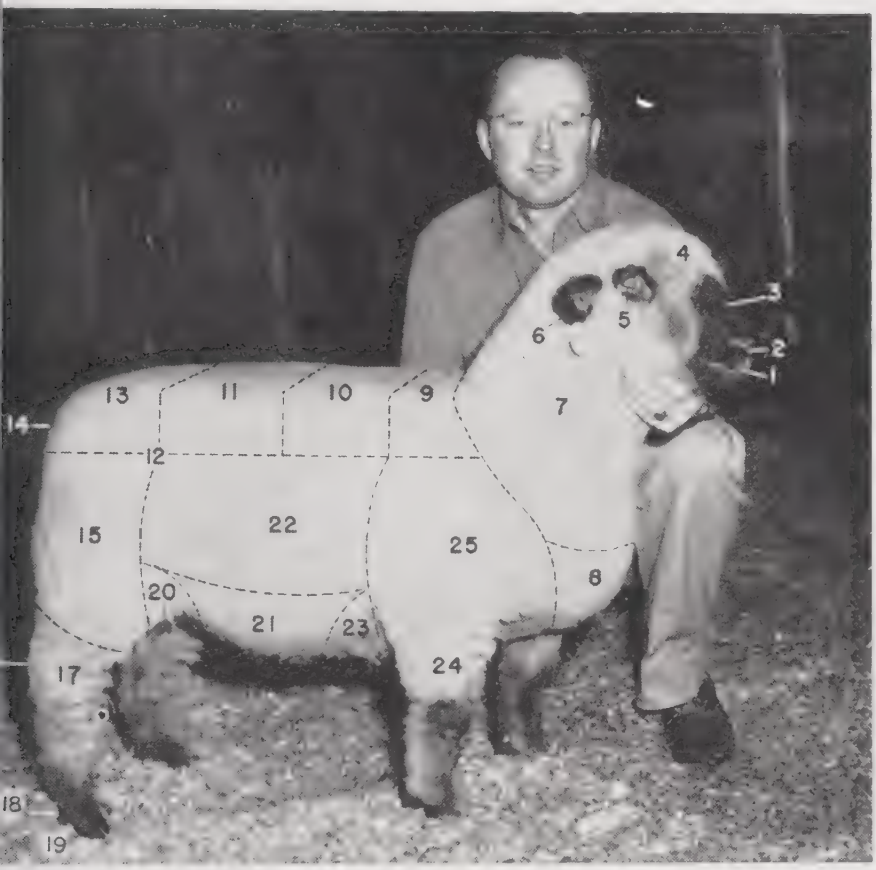


Fig. 222. Parts of a sheep. The first step in preparation for judging p consists in mastering the language that describes and locates the dif- nt parts of the animal. (The Hampshire wether shown above was Grand mpion over all breeds at the 1948 Chicago International. Bred and ex- ed by the University of Wyoming, Laramie, Wyoming.)

Mouth	8. Breast	15. Thigh	22. Ribs
Nostril	9. Top of shoulder	16. Hock	23. Fore flank
Face	10. Back	17. Hind leg	24. Fore leg
Forehead	11. Loin	18. Dew claw	25. Shoulder
Eye	12. Hip	19. Foot	
Ear	13. Rump	20. Hind flank	
Neck	14. Dock	21. Belly	

If purebred, the animals should show the characteristics of breed represented. Rams should show boldness and masculin- and ewes should be feminine.

al Fleece-Type and Conformation

When the production of wool is the main source of income, ght and quality of fleece are of the utmost importance. The rs should be long, fine, of good crimp; and the fleece should lense, clean, and bright. Animals with fleeces that show black rs or any tendency of the fleece to be hairy, loose, or open

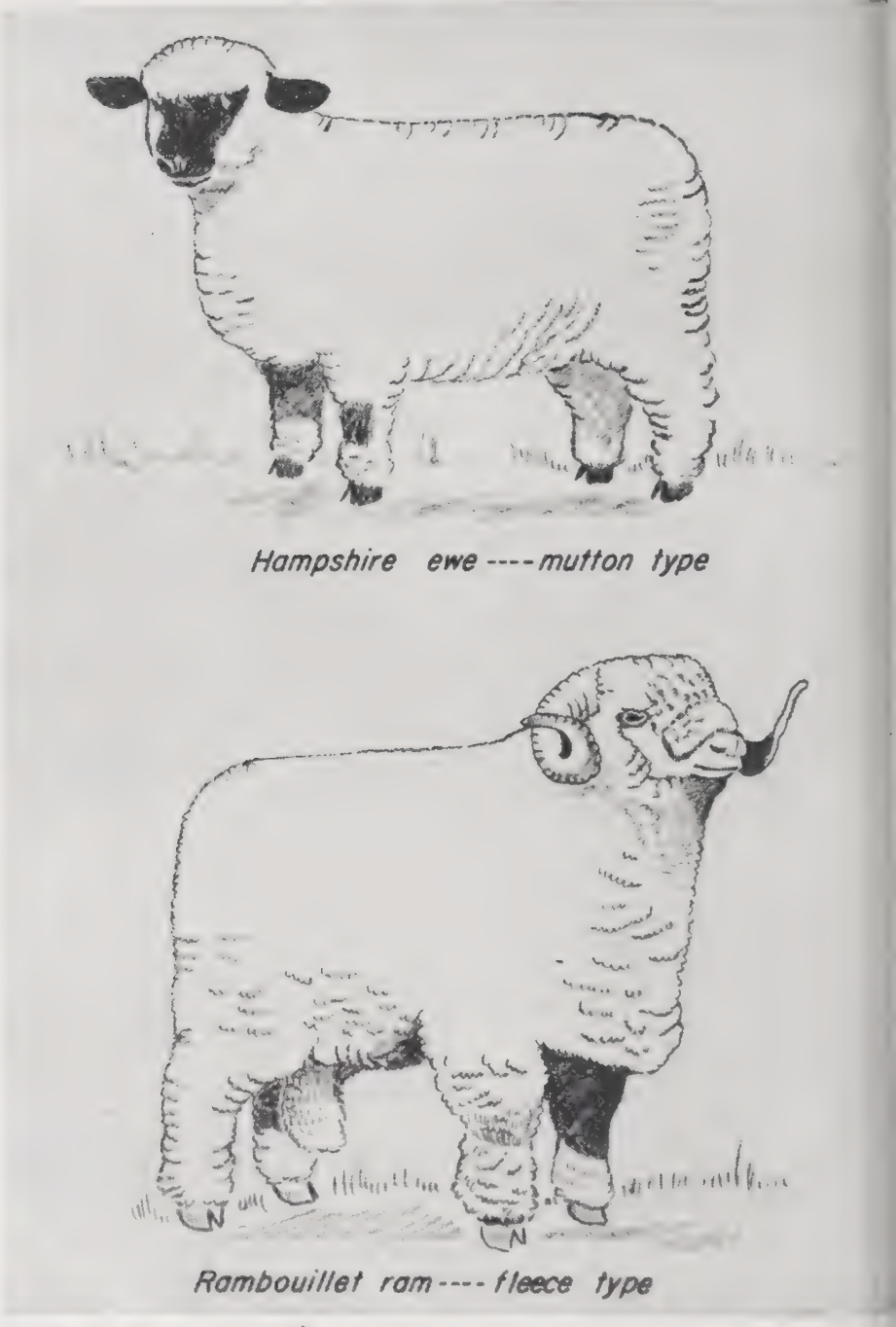


Fig. 223. The successful sheep judge must have clearly in mind an ide or standard of perfection. The ideal mutton-type is more blocky and shor legged than the ideal fleece-type. Also, when the production of wool is t main source of income, weight and quality of fleece are of the utmost i portance. (Drawing by R. F. Johnson.)

uld be rejected. From the standpoint of body form, the typi- wool-type sheep is quite different from those animals repre- ting the ultimate in mutton type. The former are more tanding and angular, with considerable less width, depth, ness, and smoothness throughout. It is to be noted, however, t the present-day smooth-bodied Rambouillet sheep are of

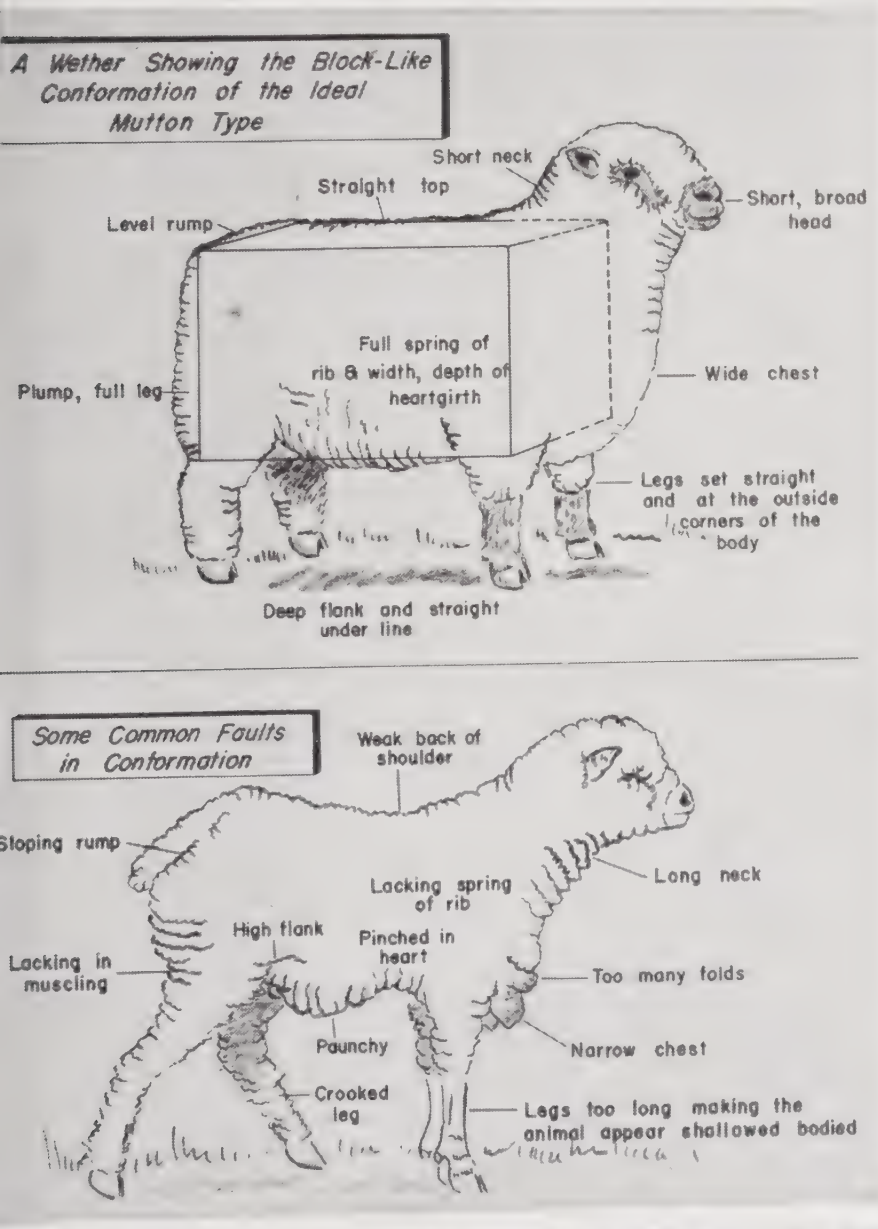


Fig. 224. Ideal mutton-type versus common faults. The successful sheep ge must know what he is looking for, and be able to recognize and ap- ise both the good points and the common faults. (Drawing by R. F. nson.)

much more acceptable mutton type than the ideal extreme wool-type of former years.

Recognizing and Evaluating Common Faults

No animal is perfect. In judging, therefore, one must be able to recognize and appraise the common faults. Likewise, credit must be given for the good points. Finally, the judge must be able to weigh and evaluate the relative importance of the characteristics that he has observed, and the degree to which they are good or bad. Skill and accuracy in this art can be achieved only through patient study and long experience. Figure 224 shows the ideal mutton type versus some common faults.

Method of Examining

As in examining any class of livestock, the examination of sheep should be systematic and thorough. This is especially true in selecting breeding animals or in close competitive judging such

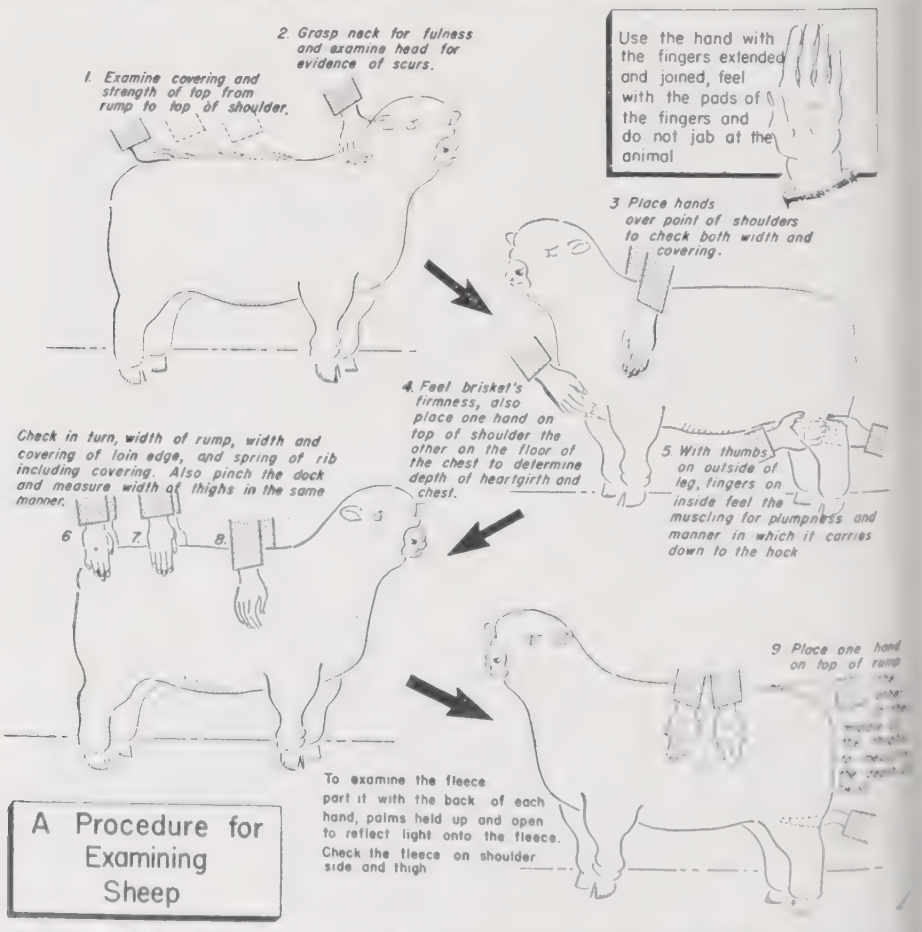


Fig. 225. A good procedure for examining sheep and some of the things for which to look. (Drawing by R. F. Johnson.)

s encountered in the show-ring, but it is neither practical essential in handling the large numbers of sheep in a central ket.

The sheep being examined should first be looked over from stance, so that views from the front, side, and rear may be red. It does not make any difference which view of the ani- is noted first, but it is important that the same procedure ollowed each time. This general inspection should furnish a l idea as to the size, balance, width, and depth of body; com- ness; the make-up of the head; length of neck; straightness ines; closeness to the ground; straightness of legs; and ed type and character of the animal. Next, the impression ed through distant inspection should be verified by handling the hands, and the fleece should be examined. Good judges er as to whether one should start handling the animal from front or rear. Perhaps as good a method as any is illustrated Figure 225.

With the market sheep, most of the examining that is neces- in arriving at the market classes and grades is done by ervation. Even so, these specialists usually like to get their ds on fat lambs; and when part of a drove of lambs is fat

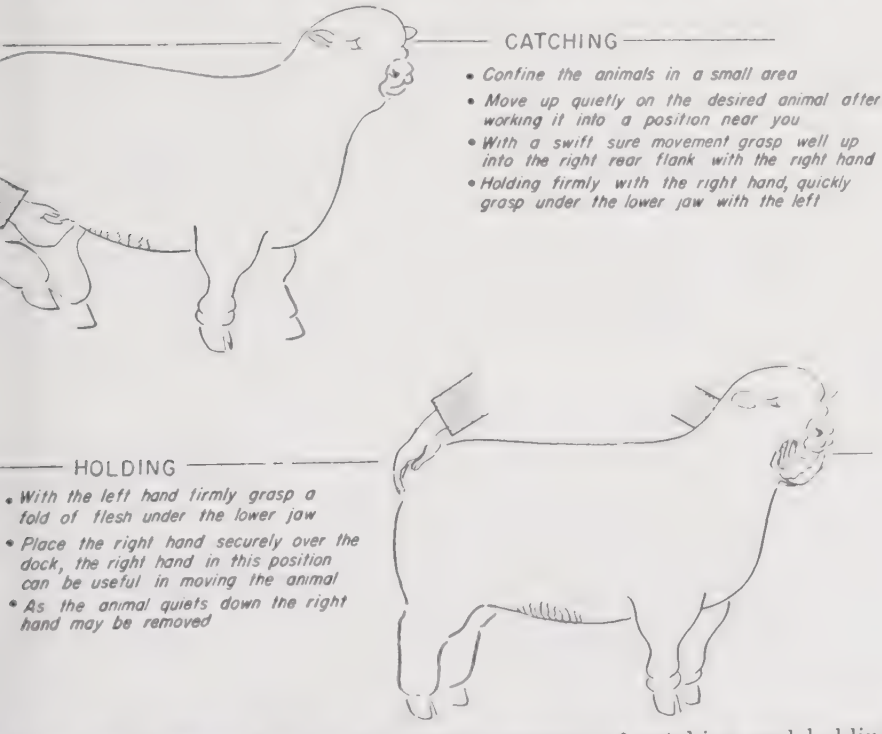


Fig. 226. Diagram showing the correct method of catching and holding eep. (Drawing by R. F. Johnson.)

enough to go the slaughter route—whereas others must go as feeders—they will make the cut after handling each of them as they file through a cutting chute.

Catching and Handling Sheep

If sheep are to be caught and handled for any reason, they should first be confined to a small corral or shed. Sheep may best be caught around the neck, by the hind leg, or by the rear flank. Never should they be caught by the wool. Such rough treatment results in badly injured skin and tissue, which may require weeks or even months to heal. As a result of such mishandling, market sheep will exhibit a damaged carcass, and the fleece of breeding animals will lack uniformity because of the disturbance in the injured area.

In handling sheep, the fingers should be kept together. In this way, the correct touch is obtained in the palm of the hand, and the wool is not disarranged. In observing the fleece and skin, the wool should be parted well down on the shoulder, side, and leg. Opening the fleece on the back should be avoided, as it will allow water to run in.

Determining the Age of Sheep

Until sheep are four years of age, the front teeth of the lower jaw furnish a fairly reliable guide as to their development. The lamb has small, narrow teeth that are known as milk teeth. At twelve to fourteen months of age, the two center incisors are replaced by two large, broad, permanent teeth. Each succeeding year, an additional pair of permanent teeth appear, one on either side of the first pair, until four years of age, when there is a full mouth. It must be remembered, however, that teeth represent the degree of development rather than the exact age according to birth, and, therefore, they are not an infallible indication of age.

After the sheep has a solid mouth (at four years), it is impossible to tell the exact age. With more advanced age, the teeth merely wear down and spread apart, and the degree of wearing or spreading is an indication of age. The normal number of teeth may be retained until eight or nine years, but often some are lost after about the fifth or sixth year, resulting in a "broken mouth." When most of the teeth have disappeared, the animals are known as "gummers."

Ewes of mutton breeding usually start on the decline at about five years of age, whereas ewes of the fine-wool breeds

not begin to decline until about a year later. Even so, outding producers should not be disposed of just because they e reached this age, especially in a purebred flock. Also, anis that have reached the age where it may no longer be wise xpose them to the rigors of range handling may often be red satisfactorily and profitably in a farm flock for one to two rs longer.

With market sheep the "break-joint" or "lamb-joint" is also important criterion of age. For further information on this nt, the reader is referred to Chapter XXIII.

Determining the Age of Sheep By Their Teeth

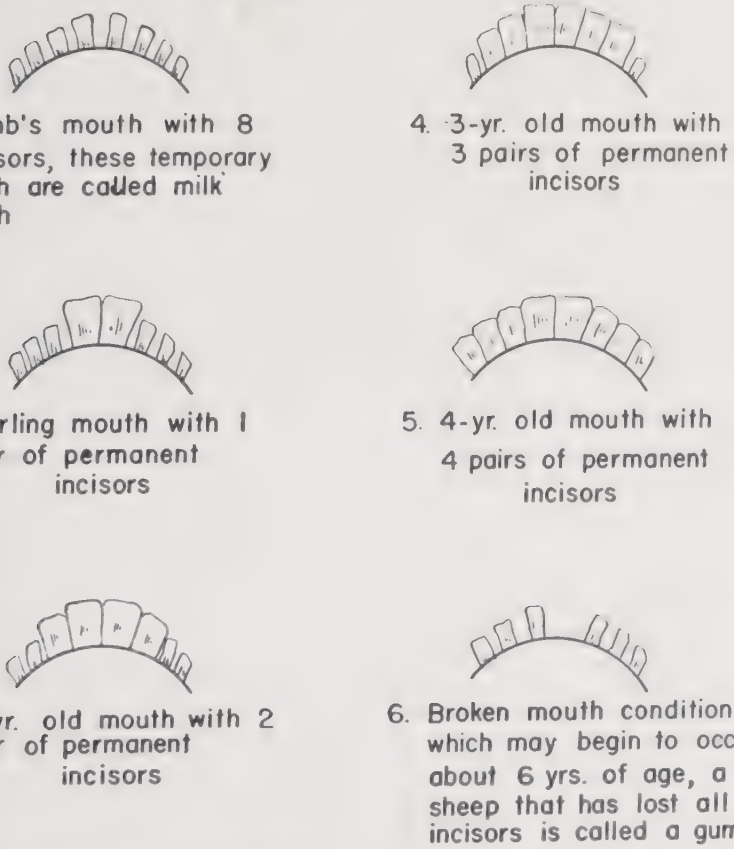


Fig. 227. Diagram showing how to determine the age of sheep by the h. (Drawing by R. F. Johnson.)

CHAPTER XX

SYSTEMS OF SHEEP PRODUCTION

It is logical that different systems of sheep production should exist in a country so large and diverse as the United States. This is fortunate, both from the standpoint of (1) the most efficient utilization of production factors, especially feeds, and (2) the meeting of consumer needs. For purposes of convenience and discussion, the different systems of sheep production are herein grouped into the following categories: (1) the farm flock method, (2) the purebred flock method, (3) the range band method, and (4) lamb feeding. Although the system of sheep production and the size of the enterprise may introduce new problems, the fundamental nature of sheep remains the same. For this reason, there is neither as much difference nor as many secrets to success in different systems of sheep production as some would have us believe. Essentially, success in any area or system depends upon maintaining a healthy and highly productive flock that is economically managed and upon the advantageous marketing of the lamb and wool crop.

THE FARM FLOCK METHOD

The farm flock method is the common system of sheep production in the humid farming areas of central, southern and eastern United States. In general, it accompanies a diversified and intensive system of farming. Since it stresses market-lamb production, with wool production of secondary importance, most of the sheep in the farm flock states are of mutton-type. Farm flocks range in size from six or eight head to four hundred or five hundred head. The commercial farm flock is not under the care of a special shepherd or herder, but its handling is entrusted to a farm worker who has other responsibilities. For this reason, it is often neglected as a minor enterprise, especially when the flock is very small and the caretaker has other assignments which are considered more important and remunerative.

During the grazing season, farm flocks usually compete with beef and dairy cattle for the use of permanent or seeded pastures. Because many of the soils of the humid region are subject to considerable erosion, there appears to be a tendency

seed increased acreages to pastures, thus providing more sses. Also, on many farms, sheep are considered scavengers, as such they are given the assignment of keeping down the ds and grass of fence rows, lanes, and draws. For best results, ecially from the standpoint of greater efficiency of production parasite control, however, the farm flock should be given ter pastures, and a system of pasture rotation should be owed.



Fig. 228. The farm flock method. A flock of commercial sheep on the n of Mrs. J. F. Smith, Vilas, North Carolina. This flock produces early ket lambs. (Courtesy, National Cottonseed Products Association, Inc.)

E PUREBRED FLOCK METHOD

For the most part, purebred flocks are comparatively small l the vast majority of purebred breeders are located in the m flock states. There are, however, a sizeable number of pure- d flocks in the range states, some of which are quite large and handled by range-band methods.

In general, the purebred sheep breeder has as his objectives sale of rams to commercial sheepmen and the sale of both ns and ewes to established or new purebred breeders. Over eriod of years, the most successful purebred breeders are keen dents of commercial sheep production, keeping ever in mind



Fig. 229. The purebred flock method. A flock of purebred Romney ewes on the farm of C. E. Grelle, Ridgefield, Washington. (Courtesy, American Romney Breeders Association.)

that the ultimate objective in all sheep production is the sale of market lambs and wool and gauging their type or ideal accordingly.

Most purebred flocks are given much closer attention than the average commercial flock. Frequently, a full-time caretaker is assigned. Also, in keeping with the general requirements for successful purebred production—regardless of the class or breed of farm animals—more attention is given to (1) the location of the farm, (2) individual records, (3) the careful study and selection of individual sheep rather than of flocks or bands, (4) matings that will produce animals with great inherent possibilities, (5) the maximum development of animals through feeding, and (6) different methods of advertising, including showing. In brief, the production of purebred sheep is a highly specialized business, and only a few sheepmen should attempt this system of sheep production.

THE RANGE-BAND METHOD

Seventy per cent of the sheep of the United States are located on the western range, with the vast majority of these animals handled according to the range band method. Each band is under the care of an experienced herder who moves the animals over a comparatively large area of unenclosed land. In southwestern United States, however—in Texas, Oklahoma, and



Fig. 230. The range-band method. Typical band of grade Rambouillet on a western range. Note the herder's camp wagon. (Courtesy, The l Bureau.)

h of northern New Mexico—nearly all of the range is fenced. ler the latter conditions, the management of sheep is very ilar to that existing in Australia and New Zealand.

The relative emphasis on lamb and wool production in the ge area varies according to the rainfall and vegetation. In arid and semi-arid regions of the Southwest, where feed is sufficient for satisfactory grass-fat lamb production, the duction of wool is of greater relative importance than in those as where the vegetation is more abundant. Even so, at the sent time, lambs constitute the major source of income in se areas. In general, however, the sheep of this area are ller, produce finer quality wool, and practically all the lambs the feeder route for fattening in more distant areas where ds are more abundant.

In the semi-arid and sub-humid areas of the West and thwest, where the ranges are more lush, many of the lambs the slaughter route at weaning time, being fattened entirely milk and grass. Most operators in this area produce feeder bs only because the range has been poorer than normal. The n source of income, therefore, is derived from the sale of bs, with the income from wool being of secondary importance. e sheep of this area are larger—large Rambouillets or long- l X fine-wool crossbreds predominating—produce coarser l, and yield lambs of more desirable shape and meat quality.

LAMB FEEDING

Lamb feeding is a highly specialized system of sheep production. In general, where pasture or range conditions are sufficiently good, the sheepman strives to produce grass-fat lambs at weaning time. When the vegetation is not good or if for other reasons the lambs lack finish at weaning time, they are usually sold for further fattening. Seldom does the producer attempt to fatten out his own feeders. Most lamb feeders are large, specialized operators whose feed lots are located in close proximity to adequate and economical feed supplies, such as irrigated valleys, mill centers, or areas where winter wheat fields may be grazed. A full discussion of lamb-feeding methods and problems is contained in Chapter XXII.



Fig. 231. The lamb feeding method. Lambs in a feedlot near Torrington, Wyoming. (Courtesy, C. B. & Q. Railroad.)

CHAPTER XXI

BREEDING SHEEP

As with other classes of farm animals, sheep breeders are wo types: namely, (1) commercial producers, and (2) pure-d breeders. The commercial producers are primarily concerned h securing a high percentage lamb crop and with the utility tures of the animals and their ability to make efficient use of ds. These men direct most of their effort toward improvement ough the selection of purebred rams.



Fig. 232. Good breeding and wise management are essential for the essful production of sheep on the farm or range. This flock is grazing Traver Ranch, Glenwood Springs, Colorado. (Courtesy, National Cotton-Products Association, Inc.)

The purebred breeders are interested in producing rams for e to the commercial sheepmen and, at the same time, in fur-r improving their own flock and selling both ewes and rams other purebred breeders. Although breed fancy points are en given consideration, for success over a long period of years

the purebred breeders must be ever aware of the fact that the ultimate goal in sheep production is the sale of lambs and wool.

NORMAL BREEDING HABITS OF EWES

Perhaps there is as much scientific information about the normal breeding habits of the ewe as there is about any class of farm animals. Even so, not all of the phenomenon is clear, and much work in the field of sheep breeding remains to be done.

Age of Puberty

The sex organs of ram lambs become functional at an age of four to seven months. As evidence of this fact, it is not unusual to find that ram lambs have bred a few of the ewes prior to the normal weaning time.

Ewe lambs are probably somewhat slower than ram lambs in reaching sexual maturity, but it must be realized that in sheep full development of the female may be reached before the onset of estrus or heat, for in sheep there are long periods (anestrus) when the female organs are not active. Generally, the first estrus in ewe lambs of the mutton breeds occurs during the fall of their first year, when they are eight to ten months of age; whereas in the more slow-maturing Merinos, it may be delayed until they are sixteen to twenty months of age.

Age to Breed Ewes

Most ewes are bred during the first breeding season after they are one year of age, producing their first lamb when approximately twenty-four months old.

As a rule, ewe lambs are not used for breeding purposes. Range sheepmen almost never follow the practice, and only comparatively few farm flock owners breed ewe lambs so that they will drop their first lambs when approximately twelve months of age. Limited experimental work plus practical observations would indicate that the following results may be expected from the practice of breeding ewe lambs:

1. Growth of bred lambs is retarded temporarily but is not stunted permanently.

2. Wool yield is not affected by early breeding.

3. Some ewe lambs do not conceive; birth weights of lambs born to ewe lambs are lighter; and more troubles are encountered at lambing time (more ewes require assistance at lambing and more lambs are disowned).

4. If computed on the basis of total lifetime production up five or six years of age, ewes bred as ewe lambs will show re lambs and total pounds of lambs produced per ewe than es bred at the normal yearling age. Many good sheepmen are the opinion that Suffolk rams should be used if ewe lambs are d to black-faced rams, for the reason that the smaller head and ulders of the progeny will cause less difficulty at lambing time.

at Periods

The duration of estrus in ewes ranges from three to seventy urs, with an average of twenty-eight hours. Unlike other farm mals, the ewe shows no visible external indications of heat, acceptance of the ram (or teaser with an apron on) being the y method of external detection. Ovulation seems to occur late the heat period, usually from about twenty-four to thirty urs after the onset of estrus. If the ewe is not bred or if she s to get in lamb, estrus recurs after an interval of fourteen to eteen days, with an average of sixteen and one-half days.

station Period

The period of gestation of sheep varies between breeds and lividuals, with the usual range between 144 to 152 days. dium wool breeds, including the "down" breeds, have short station periods of from 144 to 148 days; whereas the fine wool eeds, such as the Merino and Rambouillet, have long gestation riods ranging from 148 to 152 days. The long wool breeds, such the Lincoln and Romney, have gestation periods intermediate tween the medium and fine wools, averaging 146 to 149 days. lividual gestation periods within a breed may vary up to a nge of fifteen days.

RTILITY AND PROLIFICACY IN SHEEP

In general, flockmasters have long considered that twinning mportant. This is well illustrated in the following old English age: "Ewes yearly by twinning rich masters do make; the nbs of such twinners for breeders go take." There is now sub-ntial evidence to indicate that this adage was well founded.

Though twinning is inherited, it is not highly so in compari-n with certain other traits. Experimental work has shown that e heritability of twinning is about 15 per cent or lower; where-the heritability of such traits as face covering and neck folds 40 to 55 per cent.

Prolificacy in sheep is largely determined by the number of gs liberated by the ovary at the heat period, and by the amount

of fetal atrophy. If only one egg is released and fertilized, a single lamb will result unless this egg should divide so that twins are produced. Such division does not seem to occur with much frequency, it undoubtedly being true that most twins and triplets are due to the shedding of a like number of eggs, which are fertilized and complete their development.

Under natural conditions, the number of eggs shed depends on heredity, environment, and age. It is generally recognized that, because of heredity, some breeds and strains produce a higher percentage of twins and triplets than others. On the other

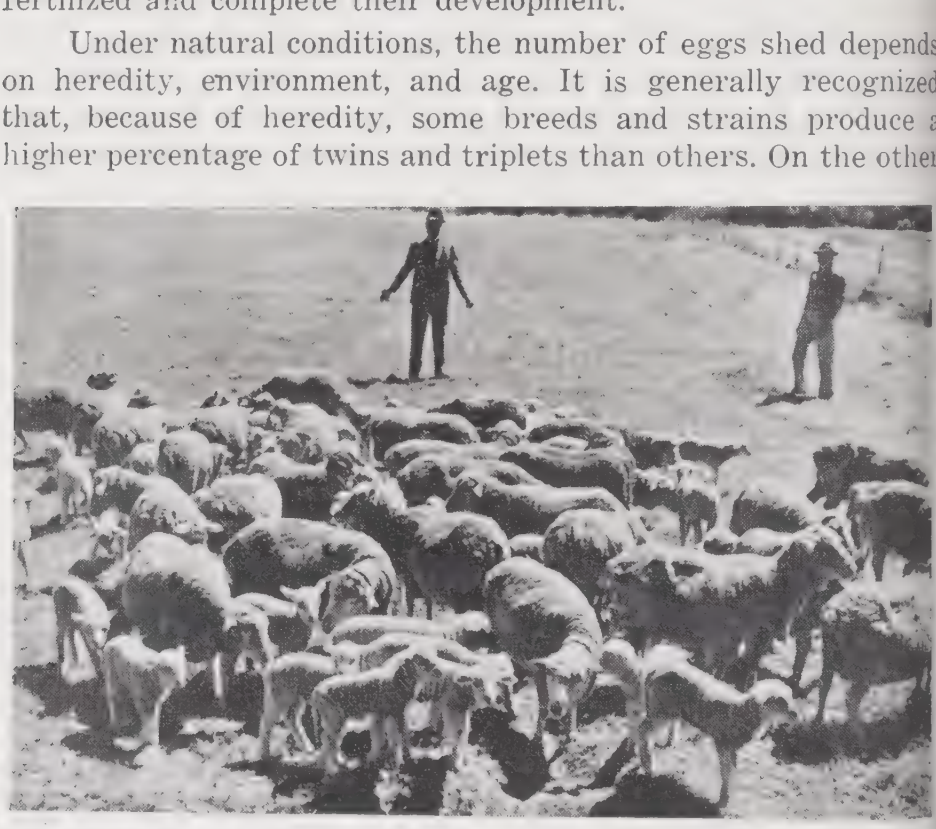


Fig. 233. A large percentage of twins is desirable. Apparently this factor is affected by heredity, environment, and age. (Courtesy, International Wool Secretariat.)

hand, under certain conditions, the number of eggs shed may be increased by "flushing," that is, through providing improved nutritive conditions prior to the breeding season. Practical observation would indicate that age is a factor in twinning, with middle-aged ewes producing a higher percentage lamb crop than either ewe lambs or very old ewes.

Where adequate feeds and facilities are available, it is generally felt that twins are desirable, for they greatly increase the weight of lambs sold per ewe. The annual maintenance requirements of ewes are not far different, regardless of whether they are producing twins or singles.

In some localities, rams of at least some of the breeds go ough a period of lowered semen volume and quality during summer months. The reasons for this phenomenon are not y understood, and limited experimental studies to date have en conflicting results. Nevertheless, there appears to be a nite seasonal difference in the fertility of rams. Where early bs are desired, this factor may be of considerable economic portance.

USHING

Flushing is that practice of feeding thin ewes more gener- ly during the period of two or three weeks immediately prior breeding. This may be accomplished either by providing more n pasture or range or by grain feeding.

Although it is not likely that all of the benefits ascribed to hing will be fully realized under all conditions, the general ing persists that the practice will result in a 15 to 20 per cent rease in the lamb crop and that the ewes will both breed lier and more nearly at the same time. Fat ewes are best ditioned for breeding by increasing the exercise.

EPARATION OF EWES AND RAMS FOR MATING

Several practices pertaining to both ewes and rams are portant during the breeding season. Each of these points will v be discussed.

mming and Tagging the Ewes

Tagging is the removal of tags or locks of wool and dirt ut the dock. It is important that this job be done prior to breeding season in order to prevent the ewes from befouling mselves and to remove obstacles for the service of the ram.

paration of the Ram for Mating

As the weather is usually rather warm at the time of the eding season, shearing the ram just prior to this will make n more active. This is especially true of old show or sale rams. here rams are not sheared completely, they should at least ve the wool clipped from the neck and from the belly in the ion of the penis, for this will result in copulation with greater e. It is also important to see that the hoofs of the ram are perly trimmed prior to the breeding season.

Marking the Ram

When a number of rams are turned in with a large band of ewes, it is impossible to detect individual rams that may be failing to settle ewes. Moreover, it is quite likely that a different ram will serve the ewe should there be a recurrence of heat, or perhaps more than one ram may serve the ewe at the time of estrus. When only one ram is being used on a small flock, however, it is important to know whether the ewes are getting with lamb. Then, too, with a purebred flock individual breeding records are rather important.



Fig. 234. Marking the ram. A breeding record can best be kept by smearing the breast of the ram and the area between his forelegs every day or two with a thick paste. (Courtesy, The State College of Washington.)

A breeding record can best be kept by smearing the breast of the ram and the area between his forelegs every day or two with a thick paste which is noninjurious to the wool. Then as the ram serves the ewe a mark will be left on her rump. Paint or tar should never be used for this purpose.

The color of the paste should be changed every sixteen days (the approximate estrus cycle of the ewe) so that one can

ermine whether ewes that have been bred are returning in at. For example, during the first sixteen-day interval, the thick ste used on the ram might well be a mixture of ordinary lubri- ing oil and venetian red; for the second sixteen-day interval, might be lubricating oil and lamp black; and for the third teen-day interval (if there is still some question about some the ewes having settled) it might be a paste made by using ricating oil and yellow ochre.

Naturally, if a good percentage of the ewes are found ning in heat for a second time, the ram should be regarded h suspicion, and perhaps another ram should be obtained. The rility in some instances may be temporary because of high dition and lack of exercise.



Fig. 235. Stud rams on pasture. A dry shelter and luxuriant pasture stitute a good combination for keeping breeding rams thrifty and virile. urtesy, The Sheepman Magazine.)

RE AND MANAGEMENT OF THE RAM

If possible, the ram should be secured considerably in ad- nce of the breeding season. At this time, better rams are ailable and the prices are more favorable. Then, too, the ram l have an opportunity to become acclimated before being ced in service. In case of show or sale rams, it may also be visable to remove gradually some of their surplus flesh.

Stud rams are usually kept separate from the ewes except ring the breeding season. Their quarters need not be elaborate expensive. Usually, a dry shelter that will provide protection ring times of inclement weather is all that is necessary. Plenty exercise should be provided at all times.

Rams may subsist largely on pasture and dry roughage. If the pasture has been scanty prior to the breeding season, the rams may be conditioned by feeding a little grain, usually not more than one pound daily. Rams are usually fed some grain when being fitted for show or sale, but it must be remembered that excess fat may actually be harmful from a breeding standpoint.

AGE AND SERVICE OF THE RAM

The number of ewes a ram will serve in a season depends on his age, vigor, and method of handling. Generally speaking, it is best not to use a ram lamb, but a vigorous, well-grown, early-maturing lamb may be used on twenty to twenty-five ewes with no apparent harm. Many good sheepmen believe that there is a definite breed difference in early reproductive capacity. A vigorous ram one to four years old that is run with the flock during the breeding season is sufficient for thirty-five to seventy ewes. When the ram is turned with the flock for only a limited period daily—perhaps an hour in the morning and an hour in the evening—or when a "teaser" is used for the purpose of locating ewes that are in heat, one mature ram may be sufficient for fifty to seventy-five ewes. Unless the ram becomes extremely nervous and restless when removed, his energy will be conserved through keeping him away from the flock; and he, therefore, will be available for heavier breeding service. Often he will remain contented if one or two wether lambs or bred ewes are kept with him. With a heavy ram and warm weather, a good plan is to allow him to run with the flock at night and to remove him to separate quarters during the day. Regardless of the system followed, the ewes should be checked daily and accurate records kept of the breeding dates. Though there is considerable variation, most range sheepmen usually plan to have three to four active mature rams with each hundred ewes.

CARE OF THE PREGNANT EWE

The requirements of the pregnant ewe are neither exacting nor difficult to meet. These needs are feed and water, exercise, and shelter.

Feed and Water

For successful sheep production, the ewes must be economically and properly fed and watered during the pregnancy period. As these requirements are fully covered in Chapter XXII, no further discussion is necessary at this point.

ercise

During periods of inclement weather and when feed is ought into the barn, ewes quite often exercise entirely too tle. As a result they become sluggish, and their blood circula- n is poor. Forced exercise may be brought about by scattering palatable roughage some distance from the shed or by driving e ewes at a moderate walk. Above all, overexertion such as ading through a deep snow or being chased by dogs should be oided. With a good winter pasture and open weather condi- ns, no other arrangements for exercise will be necessary.

elter

The shelter should be of such nature as to protect the flock om becoming soaked with rain or wet snow. Dry snow or bitter ld has no harmful effect, and up until lambing time, a shelter en to the south on well-drained ground may be entirely satis- ctory.

ARE OF THE EWE AT LAMBING SEASON

The careful and observant shepherd or herder realizes the portance of having everything in readiness for the lambing ason. If the pregnant ewes have been so fed and managed as drop a crop of strong, vigorous lambs, the next problem is at of saving the new-born animals.

As lambing time approaches, unsheared ewes should be agged." This consists of shearing the wool from around the dder, flank, and dock. The ewe should also be placed where she as plenty of room, away from any jamming or crowding. The rain allowance should be materially reduced, but the roughage llowance may be continued, if it is certain that it is of good uality and palatable. Careless feeding at this time is likely to esult in milk fever following parturition. At this time, the wool round the udder should be clipped short in order to allow the amb to find the teats readily. If breeding records have not been ept, the signs of approaching parturition must be relied upon. nervous, uneasy disposition; a sinking in front of the hips; nd fullness of udder are such indications.

he Lambing Pen

Just before lambing, or immediately thereafter, the ewe hould be placed in a lambing pen. These pens are usually four eet square and are made by placing together two hinged hurdles, hich are then set against the walls of the sheep barn. Use of he lambing pen prevents other sheep from trampling on the

new-born lamb, eliminates the possibility of the lamb wandering away and becoming chilled, and, through keeping the dam and offspring together, lessens the danger of disowned lambs.

Lambing pens should be clean, dry, well bedded, and well ventilated and should be located so as to be free from drafts. During extremely cold weather, additional warmth may be provided for the first few hours after birth by throwing a blanket over the top of the pen.



Fig. 236. Ewes in 4′ x 4′ lambing pens. Use of the lambing pen protects the newborn lamb from tramping, decreases the hazard of chilling, and lessens the danger of disowned lambs. (Courtesy, University of Massachusetts.)

Normal Presentation

A good rule for the shepherd to follow is to be near during parturition but not to disturb the ewe unless she needs help. Normal presentation of the lamb consists of having the forelegs extended with the head lying between them, although some lambs are delivered hind legs first. Even though the lambs are born in clean quarters, tincture of iodine should be applied to the navel soon after birth. The latter precaution may not be necessary when lambs are dropped on an uncontaminated pasture or range, though many range operators report that they have found it necessary to apply iodine to the navel of lambs born on the range as well as in the shed.

king the Lamb

If the ewe has labored for some time with little progress or laboring rather infrequently, it is usually time to give assis-ıce. If the lamb is not in the proper position, such assistance ısists of inserting the hand and arm in the vulva and turning lamb so that the forefeet and head are in position to be ivered first. Delivery may then be helped by pulling the young ward and downward as the ewe strains. Before doing this, wever, the fingernails should be trimmed closely and the hands d arms should be thoroughly washed with soap and warm ter, disinfected, and then lubricated with vaseline or linseed

illed and Weak Lambs

Lambs arriving during cold weather may become chilled fore they have dried. One of the most effective methods of viving a chilled lamb is to immerse the body, except for the ad, in water that is as warm as one's elbow can bear. The nb should be kept in this for a few minutes and then removed d rubbed vigorously with cloths. It then should be wrapped in old blanket, a sheepskin, or other heavy material and should given some warm milk as soon as possible. Another convenient d effective method of drying and warming a chilled lamb con-ts of putting it into a box containing a light bulb or electric ater.

When strong, healthy ewes have been properly fed and red for during pregnancy, there will be a minimum of weak nbs. The shepherd should first make certain that the mem-ane has been removed from the nostrils and that breathing has arted. Blowing into the mouth, lifting the body and dropping a short distance, working the legs, and pressing the sides are tificial methods of starting breathing that may revive lambs at at first appear lifeless.

After breathing has started and the navel cord has been inted with iodine, an attempt should be made to get the lamb nurse. Quite often even a very weak lamb will nurse the ewe it is held to the teat. If it refuses to nurse in this manner, some the colostrum of the ewe should be milked into a sterilized ttle, and the lamb should be fed a few teaspoonfuls each hour means of the bottle and nipple, until it gains strength.

If the ewe has no milk, an attempt should be made to obtain lk from another ewe that has just lambed, and perhaps in a w hours the normal flow of milk will start.

Disowned Lambs

When lambing pens are used, the number of disowned lambs is kept to a minimum. For the most part, disowning of lambs is due to improper feeding during pregnancy or because of a poor milk supply, an inflamed udder, or a maternal instinct that is not sufficiently developed, as is often true in ewes with their first lambs.

For the first few days, a ewe seems to recognize her young by scent or sense of smell. When difficulty is encountered in getting a ewe to own her own lamb or when it is desired to transfer or "graft" a lamb (as may be necessary with the loss of a lamb or when there are twins on an old ewe), deception in the sense of smell is an effective approach. One of the most common practices is to milk some of the ewe's milk on the rump of the lamb and then to smear some of it on the nose of the ewe. Many good shepherds take some of the mucus from the mouth and nose of the newborn lamb and smear it over the nose of the ewe. If these methods fail and the ewe persists in fighting the lamb away, blindfold her so that she cannot see the lamb. As a last resort, and when all other methods have failed, tie a dog in an adjoining pen. Sometimes the latter method will cause latent maternal instincts to rise to a surprising degree.

Occasionally a ewe will fail to own one of a pair of twin lambs. When this condition exists, about all that can be done is that the shepherd be patient in training the disowned lamb to nurse at the same time as its mate. Both lambs are usually kept from the ewe and turned with her at intervals.

The Orphan Lamb

A lamb may be orphaned through the death of its mother or because of the inability of the mother to suckle it. The most satisfactory arrangement for the orphan is to provide a foster mother. The good shepherd will try to have every ewe raise a lamb. There may be a ewe that has just lost her lamb or a strong, healthy ewe with just one lamb. When a lamb dies at birth and it is desired to transfer or "graft" another lamb on the ewe, two procedures are common. Sometimes a ewe will accept another lamb provided that the lamb to be adopted is first rubbed with the body of the dead lamb that it is to replace. Though a bit more bothersome, a more effective approach consists of removing the skin from the dead lamb and tieing it over the lamb to be adopted. After two or three days, the skin may be removed

adually, a piece at a time. The latter method is commonly used the range bands of the West.

When it is impossible to transfer the lamb to another ewe, must be raised on cow's milk. The problem will be simplified the lamb has received a small amount of the colostrum (the st milk) from its mother. In any event, it is well to give the nb ewe's milk for the first three or four days, before changing cow's milk. During the first two days, the orphan should be l one ounce of milk every two hours, this being given in steri- ed bottles and at 100° F. The quantity may be gradually in- eased and the intervals spaced farther apart. Cow's milk is ver in butterfat and total solids than ewe's milk, and, there- re, it should not be diluted.

ed and Water After Lambing

Following parturition, the ewe is in a feverish condition and ould be handled carefully. She may be watered immediately ter lambing, and at frequent intervals thereafter, but she ould never be allowed to gorge. It is also a good plan to take e chill off the water before giving it to her. In general, feeds a bulky and laxative nature should be provided during the st few days. A mixture of equal parts of oats and wheat bran ay be fed in very limited quantities, with all the hay that can consumed. Heavy grain feeding at this time may cause udder ouble in the ewe and digestive disturbances in the lamb. The ed may be gradually increased until the ewe is on full feed about a week.

xamination of the Udder

During the first two days following lambing, the udder ould be examined night and morning. Sometimes a lamb will rse one side only. If all the milk is not being taken by the lamb, should be milked out and the ration lessened accordingly. If e udder becomes swollen and feverish, it should be milked out, thed with warm water, and then dried. Following this, it should painted with tincture of iodine. This treatment should be peated once or twice daily, as necessary. Lambs should not allowed to suckle their mothers when the udder is in such a ndition. It is also a good plan to isolate the affected ewes from e rest of the flock.

ORMAL BREEDING SEASON AND TIME OF LAMBING

Normally, ewes come in heat during late summer or early ll, though there is both an area and a breed difference. The

breeding season is usually restricted to about four months. Although the factor or factors controlling estrus are not fully understood, the following theories exist:

1. *That the onset of the breeding season is dependent upon the coming of cool nights* is a rather widely held opinion among sheepmen. Some purebred flock owners are so convinced of the validity of this theory that they take their flocks to a higher altitude when early lambs are desired. There is no really good evidence to support this theory because: (1) not all breeds react the same way; (2) those sheep maintained in cool areas do not breed out of season; and (3) animals placed in experimentally temperature-controlled quarters have not responded differently.

2. *That the normal time of year at which ewes breed is controlled by seasonal changes in length of day, with ewes coming in heat 13 to 16 weeks after the longest day of the year.* This theory is the outgrowth of experimental studies conducted by Dr. John Hammond, noted English scientist. By shutting ewes in a barn in the evening, at twilight, and artificially controlling (by exposure to ordinary electric lights) the hours of light per day, Hammond found that the normal breeding season could be changed. There was a regular lag, with the altered breeding season coming 13 to 16 weeks after the change from more hours of light daily to less hours of light daily. The anterior pituitary is recognized as the organ activated by the light stimulus. According to Hammond, this experiment explains why, under natural conditions, sheep breed 13 to 16 weeks following the longest day of the year, the sexual season being a response to decreasing daily amounts of light. This theory is supported by the observation that ewes shipped from the northern hemisphere to the southern hemisphere (or vice versa) change their breeding season to conform to the seasons of the new environment.

Under experimental conditions, certain hormone injections have caused ewes to come in heat and breed out of season. At the present time, this type of induced estrus and out-of-season reproduction is of scientific interest only, without practical application.

There is no question that a breed difference exists. The Dorset, Tunis, Merino and Rambouillet breeds will mate much earlier than the other breeds. Therefore, animals of these breeds or ewes carrying a predominance of such breeding are especially valuable to the man who desires to produce hothouse lambs.

STEMS OF LAMB RAISING

In general, four systems of lamb raising are practiced in the ted States—namely, (1) hothouse lambs, (2) Easter lambs, spring lambs, and (4) lambs raised on grass.

house Lambs

These are lambs produced out of season—principally for the ton and New York markets—and sold from December to il. The lambs are dropped in the fall or early winter months are ready for market in six to twelve weeks, weighing thirty ixty pounds live weight. As the ewes must be bred out of son for this type of market lamb production, those individu- carrying a predominance of Dorset, Tunis, Rambouillet, or ino breeding are usually used in the production of hothouse bs. Generally, these ewes are mated to rams of the mutton eds.

This system represents a highly specialized business, and man entering it must, first of all, have assurance of his rket. Then, of course, in addition to having heavy milking s of the proper breeding, he must properly house and skill- y feed the lambs and ewes in order to produce the fancy cass in demand. Hothouse lambs should be castrated; but uliarly enough, on certain markets, notably the Boston mar- the consumer demand is for lambs that have not been docked. usual explanation of the demand for undocked hothouse bs is the fact that the city consumer associates the tailless dition with older sheep only, thus having considerable question ut the age of a hothouse lamb should it be docked. Because of high moisture content of the young carcass, the pelts are usu- left on hothouse lambs until the carcass is ready for delivery he consumer.

ster Lambs

The Easter lamb trade has been a variable one, the demand ng within a rather wide range both as to weight and quality lambs. During the past several years, there has been a con- erable Easter trade demand for light lambs, twenty to thirty nds in weight and not carrying much finish. At the same ne, there is always a rather constant demand for heavier nbs of higher quality and for which good prices are paid.

ring Lambs

Young lambs marketed in the spring of the year, and prior July first, are referred to as *spring lambs*. This class is not to



Fig. 237. Ewes and lambs on grass. This is the most common system of lamb production throughout the United States and the nearly universal method on the range. (Courtesy, Dr. T. D. Bell, Utah State Agricultural College.)

be confused with *lambs* born the previous year but which are marketed the following spring, perhaps following a period in the feed lot. The first spring lambs usually come from the southwestern states and California.

After July first, the market classification of spring lambs no longer exists, animals of similar birth simply being known as lambs. Likewise, after July first, those previously designated as lambs are yearlings (wethers) or yearling ewes.

Lambs Raised On Grass

The fourth general system of market-lamb production is that of having the lambs arrive in the spring and producing them to marketable weight entirely on milk and grass. This is the most common system of lamb production throughout the United States and the nearly universal method on the range. Lambs handled in this manner must have the benefit of lush pastures, otherwise it will be necessary to market them via the feeder route. They also are generally more subject to parasites than earlier lambs, and they sell on a somewhat lower market but the cost of production is relatively low.

CROSSBREEDING IN SHEEP

Although the common systems used in breeding sheep are not unlike those applied to other classes of farm animals, there appears to be more crossbreeding among sheep because of (1) the

t that sheep are called upon to produce two products, lamb and
ol, (2) the many diverse conditions under which they are pro-
ed, and (3) the conviction on the part of many sheepmen
t the hybrid vigor of crossbreeding accounts for increased
or and livability in the lamb crop. Crossbreeding, therefore,
xtensively followed in the commercial sheep production on the
stern range. The ewe bands are predominantly of Rambouillet
raction; whereas, for market-lamb production, Hampshire
l Suffolk rams are generally used. The Rambouillet ewe bands
desired because of their (1) gregarious or flocking instinct,
great hardiness, and (3) superior shearing qualities. On the



Fig. 238. Hothouse lambs produced from a three breed cross: Dorset Merino ewes mated to a Southdown ram. (Courtesy, P. T. Ziegler, Pennsylvania State College.)

ner hand, lambs of this breeding are not so desirable for mar-
t lambs. Thus mutton-type rams are used in order to get large,
st-growing lambs that will attain a good market finish on milk
d range vegetation or that can be readily sold to go into feed
s for further finishing. As black-faced crossbred lambs of this
pe are not suitable as flock replacements, both ewe and wether
nbs are marketed. Replacement females are obtained by: (1)
tright purchase from a sheepman who has used white-faced
ms (Rambouillets, Columbias, Targhees, or Panamas) for pur-
ses of raising animals for sale as replacements, (2) using
hite-faced rams on the band every third year and retaining
e ewe lambs (some sheepmen with several bands simply use
rtain bands for producing lambs for replacement purposes), or

(3) using both white-faced and black-faced rams simultaneously on the same ewe band. In the latter type of program, the better white-faced ewe lambs—which are easily recognized as the offspring of the white-faced rams—are selected out for breeding purposes.

As can be readily surmised, crossbreeding in sheep does make for a considerable problem from the standpoint of producing or purchasing replacement animals. It also often makes the ram problem a difficult one. This practice, however, was born of necessity, there being few or no existing breeds or types possessing all the desirable features needed. In recent years, considerable effort has been made toward developing breeds of sheep better adapted to the needs, with the hope of alleviating the necessity of crossbreeding. The Columbia, Targhee, and Panama breeds bid fair to fulfill these requirements, but, unfortunately, it will be many years before there are adequate numbers with which to stock the western range.

In addition to the crossbreeding common to the western range, most hothouse lambs are produced through using this system of breeding. Usually grade Merino or Dorset ewes are topped with a Southdown ram. Ewes of this extraction will breed out of season, and they are excellent milkers; whereas the Southdown rams impart to their progeny the ultimate in early maturity and mutton type. Crossbreeding has also gained in popularity in Kentucky where crossbred Hampshire-Rambouillet ewes are frequently bred to Southdown rams for the production of grass-fat lambs.

Crossbreeding in sheep is still extensively followed in England and New Zealand. Here again, this practice is attributed to the diverse areas in which sheep are produced and the great differences with respect to the demand for the products of sheep.

Regardless of the area or the objective in crossbreeding sheep, utility points rather than breed fancy points are of paramount importance. Thus, on the western range, mutton-type rams used in crossbreeding must possess size, scale, and ruggedness; there must be no tendency to wool blindness; and the head must not be so large as to cause excessive difficulty at lambing time.

LETHALS AND OTHER HEREDITARY ABNORMALITIES IN SHEEP

Table 38 lists several lethals in sheep. Though strictly nonlethal, other hereditary abnormalities of practical importance

TABLE 38

SOME HEREDITARY LETHALS THAT HAVE BEEN REPORTED IN SHEEP

Kind of abnormality	Description of abnormality	Probable mode of inheritance
Amputated	Born with no claws on feet.	?
Dwarfism	Short legs, thick shoulders, bulging forehead.	Recessive
Earless and cleft palate	Often associated with tripartile claws; affected lambs born alive.	Recessive
Lethal gray	Presumed homozygous gray lambs die early in life; digestive disturbances associated with cause of death. Condition reported in Karakul and Turkanas breeds.	Recessive
Muscle contracture	Lambs born with legs rigid and wry neck. Usually stillborn.	Recessive
Nervous incoordination	Incoordination causing the lamb to be unable to stand after birth.	Recessive
Paralysis	Hind limbs paralyzed; affected lambs born alive but live only few days.	Recessive
Rigid fetlocks	Rigid fetlocks; skeleton, including skull, deformed; associated with short wool and a hernia; affected lambs born alive.	Recessive

in sheep include overshot and undershot jaws. *An overshot jaw is one in which the lower jaw is shorter than the upper;* whereas *in undershot jaw the lower jaw is longer than the upper.* Either condition is of practical significance because affected animals cannot graze well. Genetically, these conditions are thought to be due to the interaction of several gene pairs, possibly recessive in nature. Affected animals should be culled from the breeding flock.

Production Testing Sheep

In Chapter II, it was emphasized that: (1) To make breed improvement, either individual merit testing or progeny testing is imperative; and (2) to select intelligently on the basis of a testing program, the breeder must have adequate records and use them.

As testing records are of greatest value for those traits having the lowest heritability, it is well to list the records of greatest value in selecting breeding rams or ewes, in order of heritability (from lowest to highest). In ascending order of heritability for sheep, these are:

1. Type and finish at weaning time.
2. Prolificacy.
3. Weaning weight.
4. Fleece weight and quality.

Figure 239 shows the individual ewe record form in use at The State College of Washington. Although it is expected that the record form devised will vary according to relative emphasis and importance of lamb and wool production and personal preference of the operator, some such form as this is very necessary.

Breed Reg. No. Ear Nick Tattoo Birth Date

Sire

.....

.....

.....

Dam

.....

Type of birth (Single, Twin) Date

Bred by Temperament
(Gentle, nervous)

Bought from

Address Face Covering[6]
(As a lamb)

Date Purchased

Type, Weaned[1] Date..... Face Covering[6]
(As yearling)

Type, Yearling[1] Date.....

Back[3] Rump[3] Leg[4] Disposed to Date.....

Defects & Abnormalities[5] Why Disposed[11]

LAMBS (Use one line for each lamb)

Date of birth	Ear nick and No.	Vigor at birth	Type of birth	Type of rearing[2]	Sex	Birth Wt.	Defects and abnormalities[5]	Sire	Milking ability - ewe[9]	Weaning age, days	140 Day Weight	Weaning condition[10]	Weaning type[1]	Disposition[11] or remarks

[1] Trueness to breed appearance and desired mutton conformation:
"1" Excellent, "2" Good, "3" Medium, "4" Fair, "5" Poor.

[3] Straightness, strength, and spring of rib at width.
"1" Excellent; "2" Good; "3" Medium; "4" Fair; "5" Poor.

[4] Width and leveiness: 1-2-3-4-5 as above.

[5] Plumpness of thigh: 1-2-3-4-5 as above.

[6] Including overshot or undershot jaw, scurs, black fiber, etc.

[9] "1" Not covered beyond poll; "2" Covered to eyes; "3" Covered slightly below eyes, but open faced; "4" Covered partially below eyes, but not subject to wool blindness; "5" Face covered and subject to wool blindness.

[2] S—Single, T—Twin, Tr—Triplet.
[8] S—Single, T—Twin, Tr—Triplet, Gr—Grafted on foster mother and give her number.

[9] Good, medium, poor.

[10] Condition or degree of fatness:
"1" Excellent; "2" Good; "3" Medium, "4" Fair; "5" Poor.

[11] Cause of death, reason for disposal, kept for breeding purposes, whom sold to.

Fig. 239. Individual Ewe Record. Form in use at the State College of Washington. (See continuation for reverse side of record form.)

WEIGHT RECORD OF EWE

Date	Age	Weight	Condition[1]	Remarks[2]

REMARKS

(For example: bad udder, poor mother, aborted, veterinary treatment and nature of ailment.)

Date:	Remarks:

FLEECE

(Use one line for each year)

Length Side[3]	Fineness[4]			Date of Shearing	Days Growth	Grease Weight	Per cent of Yield	Clean Wt.	Color of Skin	Purity[5]	Remarks About Fleece
	Shoulders	Side	Thigh								



Fig. 240. Columbia sheep grazing on the ranch of Ernest White spell, Montana. Sheep consume a higher proportion of roughage than other class of livestock. (Soil Conservation Service photo. Courtesy, . & Q. Railroad Co.)

CHAPTER XXII

FEEDING SHEEP

Sheep consume a higher proportion of forages than any er class of livestock, it being estimated that 95 per cent of the al feed supply of the United States sheep production is de- d from roughages. Sheep are naturally adapted to grazing on tures and ranges which supply a variety of forage plants, and y thrive best on forage that is short and fine rather than high coarse. Although sheep will eat considerable quantities of ds and brush, they prefer choice grasses and legumes.

Except at lambing season, sheep seldom receive much grain. the northern latitudes, farm flock ewes are frequently given m three-fourths to one pound daily of a grain ration in addition the roughage allowance from about a month before lambing he time that they are turned to spring pasture. Higher levels rain are fed during the suckling period than during gestation. ny of the farm flocks of the South and range bands of the thwest, however, are kept in good thrifty condition, and the bs are raised to the marketing stages, without the feeding any grain. In still other areas, the ewes are fed only during

periods of deep snows or extended droughts. The range bands in the colder regions of the West are normally fed alfalfa hay and grain during the period of about three to four weeks that they are confined to the lambing camp.

In general, for practical reasons, the ration of ewes should consist of as nearly year-around pastures as possible, with well-cured hay and other forages available the balance of the year, plus a limited grain allowance under certain conditions. Good quality sun-cured hay and lush pastures will not only provide most of the necessary proteins but they also are excellent sources of calcium and the vitamins, especially viamins A and D. As with fattening cattle, fattening lambs require a liberal allowance of grain.

SPECIFIC NUTRITIVE NEEDS OF SHEEP

As with other classes of livestock, the nutritive needs of sheep may be classified as (1) protein needs, (2) energy needs, (3) mineral needs, (4) vitamin needs, and (5) water needs. Each of these nutritive needs will be treated separately.

Protein Needs

Since wool is a protein product, sheep need feeds that contain a liberal supply of this nutrient in order to produce a good wool clip. Wool is especially rich in the sulfur-containing, amino-acid cystine, but this requirement is usually amply met by the cystine of feeds or by methionine, another amino acid which is also rather widely distributed in natural sources and which is derived from rumen synthesis.

Growing lambs have a higher protein requirement than mature ewes. Also, ewes have both a high total nutrient and high protein requirement during the latter part of pregnancy and when suckling lambs. Though correspondingly less because of their smaller body size and lower milk production, the nutritive requirements of ewes that are nursing lambs are much like those of lactating cows.

Green pastures and legume hays (alfalfa, clover, soybeans, lespedeza, etc.) are excellent and practical sources of proteins for sheep in most areas. Where the ranges are bleached and dry for an extended period or legume hays cannot be produced for winter feeding, however, it may be desirable to provide sheep with such protein-rich supplements as linseed meal, cottonseed meal, and soybean meal at the rate of about one-quarter to one-half pound per ewe per day. As with other ruminants, where

of these essential amino acids are synthesized by micro-
nisms in the paunch, the quality of proteins is of less im-
ance in feeding sheep than in feeding swine. Accordingly,
eins from plant sources are quite satisfactory. In general,
eep have access to green grass or a reasonable quantity of
me hay, there will be no deficiency in either the quantity or
ty of proteins.

gy Needs

As with beef cattle, the energy needs of sheep are largely
through the consumption and digestion of roughages. In
ral, sheep subsist on an even higher proportion of roughages
ncentrates than do beef cattle, and this applies to fattening
s. The bacterial action in the paunch of the sheep efficiently
erts roughages into suitable sources of energy.

eral Needs

The mineral requirements of sheep and beef cattle, both
inants, are not far different. Moreover, these two classes of
als more or less compete with each other for much the
e land areas throughout the world. They are subjected, there-
to many of the same nutritive deficiencies. In their grazing
ts, sheep do differ from cattle in that (1) they show a
ded preference for short, fine forages, and (2) they have the
arious or flocking instinct.

LCIUM:

Since legumes are generally high in calcium, the require-
ts for this mineral are usually met when the winter forage
breeding ewes or the roughage for fattening lambs consists
ne-third or more of a good quality legume hay. When non-
me forages are fed (whether in the form of dry forages or
ures), there may be a decided lack of calcium in the ration,
cially if the forage is produced on a soil low in this mineral.
er such conditions, the animals should be allowed free access
calcium supplement (bone meal or ground limestone are
monly used, preferably in mixtures with ⅓ salt) or one-
th ounce of one of these supplements should be added to the
y ration.

OSPHORUS:

As is true with cattle, sheep will suffer from an acute phos-
rus deficiency if they are forced to subsist entirely on feeds
duced on phosphorus-deficient soils. Because of the high phos-
rus content of the cereal grains, fattening lambs will usually

secure an adequate allowance of this mineral, unless a high proportion of beet by-products or other low phosphorus feeds are used. Regardless of location and feeds or whether the breeding flock or fattening lambs are involved, it is good protection to allow the animals access to bone meal (preferably a mixture of ⅓ salt and ⅔ bone meal) at all times.

SALT:

Sheep are particularly fond of salt and consume considerably more per hundred pounds of live weight than do cattle. The range man commonly estimates his salt needs for the year on the basis of twelve pounds per ewe. Breeding sheep may consume nearly one-half ounce per head daily and fattening lambs from one-fifth to one-fourth ounce. In the alkali districts of the West, sheep are allowed no salt other than that which they get in the alkali (alkali often runs 85 per cent or more salt). In iodine-deficient areas, stabilized iodized salt should always be provided.

When sheep are accustomed to salt, it is a good plan to let them have free access to this mineral at all times. It is to be noted, however, that death losses frequently occur if animals are given free access to salt when not accustomed to it.

COBALT:

In this country, cobalt-deficient areas have been recorded in Florida, Michigan, Wisconsin, New Hampshire, North Carolina, and New York. In these areas, sheep should have access to a cobaltized mineral mixture, usually made by mixing ½ ounce of soluble cobalt salt per 100 pounds of either (1) salt, (2) bone meal, or (3) a mixture of ⅓ salt and ⅔ bone meal.

Vitamin Needs

As with beef cattle, vitamin A is probably the only vitamin which may be deficient in the normal feeding of sheep. The fact that sheep are generally outdoors and exposed to the sunlight much of the time, even in winter, protects them from any deficiency of vitamin D. Also, hay and other sun-cured roughages are good sources of this factor. As all sheep, including fattening lambs, utilize considerable hay, they normally receive ample quantities of vitamin D in the ration.

In general, the feeds normally consumed by sheep, especially well-cured hays and green pastures, contain ample quantities of vitamin E. Vitamins K and C are synthesized. The B vitamins appear to be synthesized in sufficient amounts in the rumen of the sheep, and thus these factors are removed as a dietary essential of this species.

Sheep, especially lambs, may suffer from a deficiency of
min A where the range is dry and bleached or where the
nals are forced to subsist on a winter feed consisting pre-
inately of cereal hay or straw, poor-quality hay, or cotton-
hulls. In no instance will there be a deficiency of vitamin
hen sheep are fed on green pastures or on a winter ration
aining a reasonable amount of well-cured, leafy green hay
lage.

In certain widely scattered areas, especially under dry-lot
itions and when red kidney beans are fed, the so-called
f-lamb disease" exists. The Cornell investigators, Willman
associates, have now definitely shown that this condition
be prevented by the addition of vitamin E to the ration.
ugh vitamin E is widely distributed in natural feeds, it may
esirable, therefore, to add a vitamin-E supplement such as
at germ oil to the ration when outbreaks of "stiff-lamb dis-
" appear to be prevalent. This should be done provided that
malady is suspected of being of nutritional origin.

er Needs

Contrary to frequent but unfounded opinions, sheep do
ire considerable water. Mature animals will consume an
age of approximately a gallon per day; whereas feeder lambs
ire about half this amount. Like other classes of animals,
water consumption of sheep varies with the climate and type
eed. They consume more water in the summer than in the
ter and more when on dry feeds than when eating consider-
roots or other succulent feeds. Sheep will go for weeks
nout water when foraging on grasses and other feeds of high
sture content. This condition often prevails on desert ranges
he early spring and on many of the mountain ranges during
summer months.

EDS FOR SHEEP

Sheep are adapted to the consumption of a great variety
eeds. Most of the common feeds used by them are of plant
in and bulky in nature. The feeding of concentrates is usually
ted to the fattening of lambs and for use by the breeding
k at such special periods as the lambing season or just before
during the breeding season. Roughages constitute 100 per
of the ration of the vast majority of sheep during most
sons of the year. Most lambs are marketed as milk fat lambs
ctly off pastures or ranges without having had any grain.

Pastures For Sheep

No other class of farm animals is so well adapted to the utilization of maximum quantities of pasture as sheep. Although cattle compete with sheep for many of the same grazing areas and are also ruminants, sheep are unique in that the vast majority of the young are marketed as milk-fat animals directly off pastures.

Although there are great differences in plants, sheep are able to utilize the various grasses, legumes, weeds, herbs, and shrubs that grow on millions of acres of cultivated and uncultivated land in this and other countries. This characteristic, plus the imperishable nature of wool from the standpoint of storage and transportation, has made sheep raising a frontier industry throughout the world.

Sheep are adapted to the grazing of both fenced and unfenced holdings. In this country, most farm flocks and a limited number of range bands of the Southwest are confined to fenced areas with no herder being necessary. On the other hand, most of the range pastures of the West are utilized by migratory bands under the supervision of a herder.

Regardless of the location of the area, year-around grazing is desired. In order to obtain succulent and palatable pastures, the range bands of the West are frequently travelled to different altitudes at different seasons of the year. In the mountainous sections, the summer ranges are usually at high altitudes, the spring-fall grazing at intermediate altitudes, and much of the winter range is on the desert or lowland areas. On some ranges, such travelling is not possible, the ranges being used on a year-long basis.

During the winter months and following periods of extended drought, pastures usually become leached and bleached. Although sheep can and do utilize these forages, it must be realized that, in comparison with green growing grasses, they are lacking in nutrients, being especially low in protein and carotene (provitamin A) content. Consideraion of these facts should be given when providing supplemental feeds.

Abundant and succulent pastures are ideal for stimulating milk production in ewes. Moreover, pastures of this type are desirable from the standpoint of the limited digestive capacity of the young lamb. Accordingly, the degree of finish carried by lambs at market time is an accurate reflection of the amount and quality of the forage available on the pasture or range.

Sheep may successfully utilize either permanent or culti-
d pastures. In the range area, the vast majority of pastures
of a permanent type; whereas both types of pastures are
by native sheep.

s and Other Dry Roughages For Sheep

Inclement weather, extreme droughts, overstocked pastures
ranges, and leached and bleached pastures make it necessary
dry roughages be provided for sheep. They are fond of good
hage and make good use of it. In general, however, they
ot effectively use as much coarse roughage as cattle.



Fig. 241. Feeding hay to sheep. They are fond of good roughage and good use of it. (Courtesy, Colorado A. & M. College.)

Hays are the standard winter feed for sheep when they
ot be out on the pasture or range or when the condition
ne pastures is such as to require supplemental feeding. The
cest hay for sheep is a legume which has been produced on
le soil, cut at the proper stage, and well cured. Such hay
alatable and rich in protein (and the quality of protein is
l), calcium, and vitamins A and D. If legume hay cannot be
red, a high-quality grass-legume mixed hay will be entirely
sfactory, being much superior to a straight grass hay. Sheep
do very well for a considerable period of time when fed no
other than a good-quality legume hay, salt, and water.

Although legume hays are preferable for sheep, non-legume
s are fed extensively in the sheep-raising and lamb-feeding
s. If straight grass hays must be fed, they should be cut
n early stage of maturity. Even then, they will be lower in

protein, calcium, and vitamins than the legumes; and hence for best results, protein and mineral supplements should be provided.

Bright, early-cut corn, sorghum fodder, or stover and early-cut, green cereal hays, and straws of many kinds are fed to sheep in different areas. The feeding value of these coarser roughages varies considerably according to the stage of maturity at which they are cut, the amount of leaves, and the green coloration. Although these forages are not satisfactory as the sole roughage, especially during the latter part of gestation and in the suckling period, they may be successfully used when mixed with liberal quantities of good-quality legume hays.

Where non-legume roughages are fed, special attention should be given to providing a suitable protein concentrate and minerals, especially calcium.

Silages and Root Crops For Sheep

Silage consists of green, succulent plants which are usually harvested at an early stage of maturity, chopped and compressed tightly into a silo, and allowed to ferment. During the fermentation, a part of the sugars in the plant are broken down, with the formation of organic acids—such as lactic, acetic, and butyric acids—and the release of carbon dioxide gas. The resulting product more closely approaches green pastures in nutritive value than dry roughages of comparable quality, being higher in carotene content and perhaps superior in other factors.

Silage for sheep may be made from a great variety of plants, including corn, sorghums, cereal grains, legumes, grasses, cannery refuse, pea vines, potatoes, beets, beet tops, sunflowers, and other materials. When properly preserved and fed, silages made from any of these materials are quite satisfactory.

Most practical sheepmen prefer to limit the silage allowance to about four to six pounds per head per day, with the balance of the roughage ration consisting of hay. If a non-legume silage is used, it is important that the hay be a legume. If for some unfortunate reason a legume hay cannot be provided when a non-legume silage is fed, it is very necessary that a suitable protein concentrate and minerals should be provided.

Roots include all plants whose roots, tubers, bulbs, or other underground vegetative parts are used for feed. The important root crops for sheep are: mangels (stock beets), rutabagas (swedes), turnips, and carrots. These feeds are very succulent in nature, containing from 85 to 90 per cent or more of water

are highly relished by sheep and have a peculiarly beneficial
t upon the digestion and general thrift of animals. The only
tion to their general use is the cost and difficulty of grow-
harvesting, and storing them. For the latter reasons, roots
aised mainly by producers of purebred animals.

Roots are generally fed sliced, although some are fed whole.
re the teeth are good, practical sheepmen feel that little is
ed by slicing roots. In this country, roots are usually limited
e to six pounds per head daily, but in other countries up
elve to fourteen pounds are often allowed daily per head.



ig. 242. Ewes utilizing a root crop in New Zealand. For the most part, for sheep are stored and used as a winter feed in the United States. tesy, Dept. of Scientific and Industrial Research, Wellington, New nd.)

entrates For Sheep

Ordinarily sheep are fed few concentrates, except immedi-
before and after lambing, in conditioning ewes and rams
reeding, or when fattening lambs. During these periods, the
frequently used concentrates consist of the common farm
s: oats, corn, barley, wheat, rye and the seeds of some of
rain sorghums. Numerous by-product feeds are also utilized
heep, including those from the flour- and corn-milling indus-
beet by-products, and oil meals or cake made from soy-
s, flaxseed, and cottonseed. Protein supplements of animal
n are seldom used for sheep because they have higher values
are more suitable for other animals, especially swine and
ry.

Unless the seeds are unusually hard, none of the grains need
ground when fed to sheep. The animals prefer to do their

own grinding, and the feeds are no more efficiently utilized when ground.

FEEDING THE EWES

Success in the sheep business is largely measured by the percentage lamb crop raised and the pounds of lambs marketed per ewe. The most important factor affecting these criteria is the feed of the ewe. For purposes of convenience, the feeding of the ewes will be discussed under the following headings: (1) flushing the ewes, (2) feeding the pregnant ewes, (3) feeding at lambing time, and (4) feeding the lactating ewes.

Flushing the Ewes

The practice of conditioning or having thin ewes gain in weight just prior to breeding is known as "flushing." This may be accomplished by turning the ewes on a fresh, luxuriant pasture two to three weeks before breeding time; or, if such a pasture is not available, satisfactory results may be brought about by feeding a grain allowance of one-half to three-quarters of a pound daily over a like period of time. Oats alone is excellent, or a mixture of equal parts of oats and corn is very satisfactory. Pumpkins, broken and scattered over the pasture, are also relished and are excellent for flushing purposes. Some shepherds like to feed cabbage at this season.

In addition to any possible effect in increasing the percentage of lambs, flushing is said to result in the ewes breeding over a shorter period of time. The lamb crop will be more nearly uniform in size and easier to handle, and the ewes will be brought into good condition for winter.

Feeding the Pregnant Ewes

If a strong, healthy crop of lambs is to be expected, the ewes must be properly fed and cared for throughout the period of pregnancy. In general, this means the feeding of a suitable and well-balanced ration, together with the necessary minerals and vitamins as required for maintenance (and growth, if the ewe is not fully mature), growth of the fleece, and development of the fetus. In addition, plenty of exercise must be provided. Suitable shelter should be made available during inclement weather and the animals should be given access to an abundance of fresh air and sunshine at all times. Ewes should gain in weight during the entire period of pregnancy, making a total gain of 15 to 20 pounds for the period. They should enter the nursing period with

reserve flesh, because the lactation requirements are much rigorous than those of the gestation period.

After the ewes are bred, they should have access to pastures ng as these are available and open. When the ground is winter pasture or range or stalk or stubble fields may be ured to advantage. Green rye or wheat pastures furnish a succulent feed and valuable exercise for the flock. Where er pastures are either unavailable or inadequate, supplemen- eeds must be provided. The most satisfactory forage is a -quality legume hay—alfalfa, clover, lespedeza, or soybeans. sheep producer, however, often seems to find it difficult to legumes on the farm or ranch and rather hard to buy such hage at satisfactory prices. Where grass hay, such as native or timothy is used, every effort should be made to cut it at arly stage of maturity and to have it properly cured. Even , a protein supplement should be provided, together with ble minerals. Because of the known value of legumes from standpoint of quality of proteins, minerals, and vitamins and fact that grass hays are not recognized as too desirable for p, every effort should be made to supply at least a third of od-quality legume roughage to pregnant ewes. A 150-pound will eat about four pounds of hay daily. In order to prevent e and protect the wool from chaff and hay seeds, suitable s should be provided.

Such succulent feeds as roots and silage are desirable in ing the ewes healthy and doing well. Of the root crops, tur- seem to be preferable for pregnant ewes. Silage made from legumes, or grasses and which is not frozen, spoiled, nor y may be fed quite safely and is excellent feed. Ordinarily, daily ration of roots or silage should not exceed five pounds, h means that hay is usually fed in addition to the succulent

About a month to six weeks before lambing time, the ewes frequently given a concentrate allowance of three-fourths e pound of grain daily, the amount depending upon the qual- f roughage available and the condition of the ewes. At this , the fetus is developing very rapidly and the demands being e upon the ewe are rather heavy. The concentrate given to farm flock usually consists of home-grown grains, whereas e bands are often given pelleted or cubed protein supple- ts. Not only will good feeding result in strong, more vigorous s but the ewes will milk better.

On the western ranges, ewes are normally maintained on winter grazing areas, with or without supplemental feeds, as long as possible. Usually these ranges are located at the lower altitudes and the vegetation consists of rather mature and bleached grasses or brush and browse. When the vegetation is sparse or covered by deep snow, supplemental feeds of hays, preferably alfalfa, some other legume, or concentrates are provided. Often protein supplements in the form of pellets or cubes are used, for these may be scattered about the feeding grounds, neither being blown away nor difficult for the sheep to find. Usually such expensive protein supplements are fed only when native grass hays are being utilized, high quality alfalfa not requiring a protein supplement.

Feeding At Lambing Time

As lambing time approaches, or immediately after lambing, each ewe should be placed in an individual "holding" or "lambing pen." At this time, the grain allowance should be materially reduced, but dry roughage may be fed free choice, when it is certain that it is of good quality and palatable. Usually, some five to seven days should elapse before ewes are placed on full feed following parturition. In general, feeds of a bulky and laxative nature should be provided during the first few days. A mixture of equal parts of oats and wheat bran is excellent. Soon after lambing, the ewe should be given water with the chill removed but should not be allowed to gorge.

Feeding the Lactating Ewes

Following lambing, the feed allowance of the ewe should be increased according to her capacity and needs. Although there is great individual and breed variation, ewes will yield from one to four quarts of milk per day. In comparison with cow's milk, ewe's milk is richer in protein and fat and higher in ash. It must also be borne in mind that, in addition to producing milk and maintaining her body, the ewe is growing wool, which is protein in character. Immature ewes are also growing. Under these circumstances, it is but natural and normal to expect ewes to lose in condition during the suckling period. The loss in weight is primarily determined by the inherent milking qualities of the individual and by the kind and amount of feed.

In general, it is considered good practice to feed lactating ewes rather liberally, for lambs make the most economical gains when suckling. It is a good plan to separate the ewes with twins

n those with singles, giving the former more liberal rations the benefit of the better pastures or ranges. In fact, some ge sheep operators find this practice so advisable that they ularly separate out the twin bands.

Milk production can be greatly stimulated through the per selection of feeds. If there is not sufficient high quality ghage for the entire winter, the most palatable and succulent tion should be reserved for use during the suckling period. tures should be provided as soon as possible, but in the mean- e a high-quality legume hay or, better yet, a combination of and silage, will take care of the roughage needs. Though ying somewhat with the size and condition of the ewe and ether there are twins or merely a single, an adequate ration lactating ewes may consist of approximately four pounds of h-quality alfalfa hay plus three-fourths to one pound of grain y. With silage, the daily ration may consist of one and one- to two pounds of hay, four to six pounds of silage, and three- ths to one pound of grain. If neither a legume hay nor me silage are available, a protein supplement should be in- ed in the grain ration.

As soon as the spring-range or pasture season has arrived, use of harvested feeds should be discontinued, being both conomical and unnecessary.

EDING THE RAMS

The rams should be fed so as to remain in vigorous, active eding condition. In general, rams should be fed the same kind eeds as ewes but in slightly larger quantities. They need a erous allowance of relatively high-quality feed just before during the breeding season, when pasture is not available. ing the balance of the year, pasture is usually adequate when lable; otherwise, the ration may be comparable to that of the s.

EDING GROWING-FATTENING LAMBS

The growing-fattening stage of lambs refers to that period nding from birth to weaning at four to six months of age. no other period in the life of the sheep is the prevention isease and the promotion of growth so important.

Where succulent pastures are available, most practical pmen, including producers with both farm flocks and range ds, consider that a combination of such green forage plus the s milk is ample. In fact, lambs are unique among farm ani-

mals, inasmuch as they may be marketed at top prices off grass. Although young cattle may be sold off grass without having any other feed, they will usually fail to get sufficiently fat to bring top prices.

Frequently, farm flock lambs are creep fed grain in addition to receiving their mother's milk and pastures. Where pastures are good, it is doubtful that the practice of creep feeding is either economical or necessary, except possibly for show lambs or prior to the pasture season. Usually creep feeding on the western range is too difficult. Should the range forages not be sufficiently abundant or lush to produce fat lambs, the sheepman, therefore, usually elects to sell his animals as feeders at weaning time.

Good pastures for lambs are those that are rather succulent and that are composed of plants that are palatable and nutritious. This means green, actively growing pastures in contrast to dormant or dried forages.

Hothouse lambs are born out of season, in the fall or early winter, when pastures are usually unavailable. It is necessary that these animals be crowded for slaughter at two to four months of age, when they should weigh from forty to sixty pounds. In addition to the right breeding for this specialty, therefore, hothouse lambs must be carefully fed. In the first place, the ewes should be given liberal quantities of a good succulent ration in order to stimulate the milk flow. Secondly, the lambs should be creep fed with a palatable and suitable ration from the time they are two weeks of age until marketing.

LAMB FEEDING

Prior to 1900, sheep feeding consisted of fattening the older animals, ewes and wethers, chiefly on cheap and plentiful flour-mill by-products and prairie hay. As a result, the industry was centered near the flour-milling centers of St. Paul-Minneapolis and Chicago. In the early days, such feeding operations proved very lucrative. Huge yards were built, and thousands of sheep passed through these feeding plants. But gradually the competition for feeders increased, with the result that prices rose. Simultaneously, the by-products of the mills were found useful in feeding other classes of livestock, thus increasing in price. In the meantime, the Corn Belt farmers became interested in fattening sheep, and the market demand shifted to young lambs. All of these factors brought about the steady decline of the feed yards centered near the large flour mills, beginning about 1900. Moreover, the shift to lamb instead of mutton has been equally

ked. Today, 90 to 95 per-cent of the sheep reaching our cen- markets are under one year of age.

The primary objective of the sheepman is that of producing -fat lambs suitable for slaughter at weaning time. Only n the range is inadequate are lambs sold via the feeder route. ost all feeder lambs come from the range area. Some range s produce only a small percentage of lambs which are classed



Fig. 243. Aerial view of the Hislop Sheep Co., Granger, Washington. large lamb feeding plant, which is located in the irrigated Yakima Val- an accommodate over 20,000 lambs at one time. (Courtesy, Wm. His- photograph by Phillip Lewis.)

eeders; whereas in other areas almost all the lambs must be as feeders because the vegetation is not sufficient to promote d growth and fattening. It is estimated that, for the range as a whole, an average of at least 25 per cent of all lambs luced in any one year receive additional feed after they are oved from the range and prior to slaughter.

as and Types of Lamb Feeding

Feeder lambs are generally sold to go into districts where ns and other concentrates are abundant. Such areas include: the irrigated districts of the far West where the feeding of ar beet by-products—beet pulp, beet tops, and molasses— lominates, (2) the wheat-raising sections of Oklahoma, Kan-

sas, and Nebraska, where fall grazing of the wheat fields is practiced, and (3) the Corn Belt where stubble fields and meadows are gleaned and the corn crop may be harvested by lambs.

Colorado is the leading lamb-feeding state of the nation, fattening out one-fourth of the sheep and lambs fed in the United States. Here, locally grown alfalfa, sugar beet by-products, and barley are used extensively, along with considerable corn and protein supplements which are shipped in from outside areas.

Numerous feeding practices and a great variety of feeds are used in lamb-fattening operations. In general, however, all methods may be classified as (1) field fattening or (2) dry-lot fattening.



Fig. 244. "Sheeping down" corn on the farm of J. E. Norman, Union, Iowa. First the crabgrass, weeds and lower corn leaves are eaten. (Courtesy Wallace's Farmer and Iowa Homestead.)

Field Fattening

This method of fattening lambs is somewhat comparable to the pasture fattening of cattle, except that a greater variety of feeds are used by lamb feeders. Field feeding requires relatively little labor and equipment, and the manure is dropped back on the land where it will do the most good. Death losses run higher than in dry-lot feeding because the feed consumption cannot be controlled.

The kind of field feeding varies from area to area and even between farms within the same locality. Most of the feeder lambs are shipped to these feeding areas in August and September at the time the lambs are normally weaned from range ewes. Usu-

these field-fed lambs are ready for market in November and December, though it is not uncommon for a small percentof thin lambs to be held back for additional dry-lot fattening irty to sixty days.

Throughout the Corn Belt, feeder lambs are usually used cavengers during the early part of the field-feeding process. quently, the lambs are pastured in the stubble fields or on the dows until all these feeds are consumed, after which they turned into cornfields.



Fig. 245. Lambs fattening on winter wheat in western Kansas. In as, Oklahoma, and Nebraska, thousands of lambs are fattened prily by fall pasturing wheat fields. (Courtesy, Rufus F. Cox, Kansas College.)

In Kansas, Oklahoma, and Nebraska, thousands of lambs are ened primarily by fall pasturing of the wheat fields. In the fic Northwest, a limited number of lambs are fattened by ning the pea stubble.

-Lot Feeding

Dry-lot feeding is, as the name indicates, feeding under ricted conditions. This may either be (1) shelter or barn ing, or (2) open-yard feeding.

ELTER OR BARN FEEDING:

Because of inclement weather in the fall and early winter, h of the lamb-feeding operations in the central and eastern es is in dry lots which afford shelter. In some instances, the bs are kept under cover without an exercising lot. These ns may consist of anything from open sheds to more costly elaborate structures. In the vast majority of instances, the s are home grown, corn being the chief concentrate used in

these feeding operations. Lambs are fattened as a means of marketing the grain, conserving the fertility of the soil, and furnishing gainful work during the winter months. Most of these lambs are fattened by farmers who finish one or more carloads rather than by large operators who feed thousands of head. Practically all of the feeder lambs used in these operations come from the western ranges, either directly or via such markets as Denver, Omaha, Kansas City, St. Paul, or Chicago. After getting on full feed, these lambs are either hand-fed twice daily or self-fed.



Fig. 246. Open-yard feeding lambs in northern Colorado. This is the most common method of fattening lambs in the West. (Courtesy, Colorado A. & M. College.)

OPEN-YARD FEEDING:

Open-yard feeding is the common method of fattening lambs in the irrigated areas of the West, though a few eastern lamb-feeding operations are in open-yards. In this system, equipment costs are kept to a minimum—the facilities merely consisting of an enclosed and well-drained yard which may or may not have a natural or constructed windbreak, and the necessary feed bunks. Open-yard feeding is often used by large operators who feed thousands of lambs.

Large quantities of alfalfa and sugar beet by-products are utilized in these yards. As it is often most economical to use a

ximum of roughages, the feeding period may extend for as g as four to five months. Also, because of the desire to use a ge proportion of roughage to grain, the lambs in these western d lots are usually hand-fed twice daily rather than self-fed.

sic Considerations In Fattening Lambs

Although no rules of success are applicable to any and all nditions, the following basic considerations in fattening lambs e worth noting:

1. In lamb-feeding operations, the purchase price of the mbs represents 50 to 75 per cent of all costs. This indicates e importance of keeping death losses to a minimum.

2. Experienced feeders normally expect to lose 3 to 4 per nt of lambs on feed. This is about twice the loss that occurs in mmercial cattle-feeding operations.

3. Lamb feeding is seasonal in nature, usually extending om August to about the following May. This seasonal condition due to the fact that (1) suitable feeder lambs are not available til the late summer and fall months, and (2) following the owing and harvesting seasons, the feeders have available quanies of marketable and unmarketable feeds which may be lized by lambs.

4. As in cattle feeding, feed-lot gains are expensive, usually sting more per pound than the selling price on the market. us a reasonable margin or difference between the cost and ling price per hundredweight is necessary. Under normal nditions, the necessary margin is estimated at $2.00 per hunedweight.

5. Though the situation may vary according to the kind d comparative price of feeds available, it will require about 0 pounds of grain and 500 pounds of roughage to produce 100 unds of gain. Thus, lambs utilize feeds more efficiently than ttle.

6. In a 250-mile shipment, lambs will shrink about 5 per nt. If properly fed, watered, and cared for enroute, lambs may shipped 1,500 to 2,000 miles without much greater shrinkage an this.

7. Most feeder lambs weigh between 55 and 65 pounds when aced on feed and from 85 to 90 pounds following a 90- to 120-y feeding period.

8. Wool is of importance in selecting feeder lambs because has a bearing on their market value, the pelt being the most luable slaughter by-product.

9. Range feeder lambs are more plentiful than native feeders, thus allowing for greater selection; and usually they are more uniform and are less heavily infested with parasites.

10. Lambs are frequently fed on a contract basis, with many and varied agreements being used.

11. Wether lambs appear to make slightly more rapid gains but do not finish quite so early as ewe lambs.

12. Where western lambs have undergone a long shipment immediately after being taken from their mothers, special care is necessary in starting them on feed. After rest following shipment, lambs are usually started on grain by feeding about ¼ pound per head daily. Gradually this allowance is increased so that the lambs are getting a full feed of about 1.5 to 2.0 pounds of grain per head daily and about the same amount of hay when on full feed 4 to 5 weeks later.

13. A great variety of feeds can be used in lamb feeding. In general, the successful feeder balances out the ration by selecting those feeds which are most readily available at the lowest possible price.

14. Unless such extremely hard seeds as millet are included in the ration, it does not pay to grind feeds for fattening lambs.

FEED ALLOWANCE AND SOME SUGGESTED RATIONS FOR SHEEP[1]

Sheep rations vary with the section of the country, depending chiefly on available local feeds. Fortunately, many feeds of similar nutritive properties can be interchanged in the ration as price relationships warrant. This makes it possible at all times to obtain a balanced ration at the lowest cost.

Except at lambing time or when emergencies occur as a result of drought or inclement weather, western bands receive little supplemental feed. Even with farm flocks, a minimum of grain is fed to breeding animals. Grain feeding usually is limited to the latter part of gestation and to the lactation period prior to turning to pasture.

Tables 39 and 40 contain some Handy Feeding Guides based on rations that have been used by successful sheep operators in various sections of the country. Also, some suggested show fit-

[1]Grateful acknowledgment is given to the able assistance of three of the author's WSC colleagues in the preparation of this section, especially the suggested rations. Mr. James Nofziger computed each ration, and Dr. Burch H. Schneider and Mr. Charles Kyd made many helpful suggestions and criticisms.

Where possible these rations were computed from the requirements as reported by the National Research Council and adapted by the author.

rations follow. These are presented as guides only. Sound ment in their use should always prevail.

TABLE 39

HANDY EWE FEEDING GUIDE

ms may be fed any of the rations listed for ewes, but they should receive slightly more liberal allowances)

Type of Ration	First 100 days of gestation[1] (weighing 100 to 150 lbs.) lbs. per day	Last 6 weeks of gestation[1] (weighing 115 to 165 lbs.) lbs. per day	Ewes in lactation (weighing 100 to 150 lbs.) lbs. per day
gume hay[2] or grass-legume mixed hay, od quality	3-4	To each ration listed in the first column add ¾ to 1 lb. grain[5] daily.	To each ration listed in the first column add ¾ to 1 lb. grain[5] daily, plus ¼ lb. protein supplement to each ration having less than 2 lbs. legume.
ume[2] hay or grass-legume mixed hay, ood quality	1½-2		
ass hay or other non-legume dry roughage	1½-2¼		
gume hay[2] or grass-legume mixed hay, ood quality	1½-2		
rn or sorghum silage	4-6		
ass hay or other non-legume dry roughage	3-4		
otein supplement[3]	¼-½		
rn or other non-legume silage	8-10		
otein supplements[3]	¼-½		
ots[4]	5-6		
gume hay[2] or grass-legume mixed hay, od quality	2¼-3¼		
ass hay or other non-legume dry roughage	2-2½		
rn or sorghum silage	3-4		
otein supplement[3]	¼-½		

wes should gain in weight during the entire pregnancy period, making a total gain of 15 to 25 pounds.
he legume hay may consist of alfalfa, clover, soybeans, lespedeza, etc.
he protein supplement may consist of linseed, cottonseed, and/or soybean meal—with nutted (pea-size) prod- eferred.
he important root crops for sheep are: mangels (stock beets), rutabagas (swedes) turnips, and carrots.
he grain usually consists of whole corn, barley, wheat, oats, and/or sorghum; although other grains are used.

Some sheepmen, especially purebred and farm flock breeders, fer to feed grain mixtures rather than one grain only to ewes ng the gestation and lactation periods. Then any one of the owing mixtures may be used:

on No. 1[1]

----------50	lbs.
ey ----------25	lbs.
at bran ----------10	lbs.
beet pulp ----------10	lbs.
eed oil meal ---------- 5	lbs.

on No. 2

n or sorghum --------50	lbs.
----------20	lbs.
eat bran ----------20	lbs.
tein supplement[2] ------10	lbs.

on No. 3

n ----------60	lbs.
s or wheat bran --------30	lbs.
tein supplement[2] ------10	lbs.

Ration No. 4

Oats ----------30	lbs.
Corn ----------20	lbs.
Wheat bran ----------30	lbs.
Protein supplement[2] ------20	lbs.

Ration No. 5

Oats ----------60	lbs.
Wheat bran ----------25	lbs.
Protein supplement[2] ------15	lbs.

[1]Ration 1 is used for gestating-lactating ewes at the State College of shington. If the lactating ewes lose considerable flesh prior to turning pring pasture, the Shepherd adds a little corn to the ration.
[2]Linseed, cottonseed, and/or soybean meal.

Pound for pound, any of these mixed rations can replace the grain in any of the 7 suggested rations of Table 39, but they are (1) slightly higher in protein and dry matter, and (2) slightly lower in T.D.N.

TABLE 40

HANDY LAMB FEEDING GUIDE

(Fattening Lambs on full feed, weighing 55-90 pounds. Many lamb feeders prefer to chop the hay and mix it with the grain ration.)

	Type of Ration	Pounds per day
1.	Legume hay	1¼-1¾
	Grain[1]	1¼-1½
2.	Grass-legume mixed hay, good quality	1¼-1¾
	Grain[1]	1¼-1½
	Protein supplement[2]	0.2-0.3
[3]3.	Legume hay	1¼-1¾
	Corn or sorghum silage	3¾-5¼
	Protein supplement[2]	.15-0.2
4.	Legume hay	¾-1
	Corn or sorghum silage	1½-2½
	Grain[1]	1¼-1½
	Protein supplement[2]	0.1
[3]5.	Corn or sorghum silage	2¾-4½
	Grain[1]	1¼-1½
	Protein supplement[2]	0.2-0.3
6.	Legume hay	1½-2½
	Grain[1]	¾
	Beet pulp, wet	2-3

[1]Whole corn, barley, wheat, oats, and/or sorghum.

[2]Linseed, cottonseed, and/or soybean meal.

[3]Although these rations are occasionally used, they are controversial. Most experienced sheep feeders prefer (1) a ration with some grain to ration no. 3, and (2) not to use silage for the only roughage as in ration no. 5.

Fitting Rations for Sheep[1]

In addition to being reasonably economical (mostly home-grown) and well-balanced, the ration for show sheep must be palatable. Many feed combinations meet these specifications. The ration selected is usually determined by (1) the availability and price of feed in the area, and (2) preference and judgment of the feeder.

Some suggested grain fitting rations follow. To each of these grain rations, good quality roughage — usually home grown — should be added in about the proportions indicated in Table 40

[1]Further information on selecting, fitting, and showing sheep is presented in Chapter XV of *Sheep Husbandry*, a book by the same author and the same publisher as *Animal Science*.

dy Lamb Feeding Guide:

Rations for lambs (either creep fed or weaned lambs that are g fitted for show). Show lambs on full feed will eat about lbs. of grain per head daily:

on No. 1[1]

	65 lbs.
at bran	17.5 lbs.
eed oil meal	17.5 lbs.

on No. 2

	40 lbs.
	40 lbs.
at bran	10 lbs.
ein supplement[2]	10 lbs.

on No. 3

ey	20 lbs.
	20 lbs.
	30 lbs.
at bran	20 lbs.
ein supplement[2]	10 lbs.

Ration No. 4

Oats	70 lbs.
Wheat bran	20 lbs.
Protein supplement[2]	10 lbs.

Ration No. 5

Oats	80 lbs.
Wheat bran	20 lbs.

Ration No. 6

Corn	45 lbs.
Oats	45 lbs.
Protein supplement[2]	10 lbs.

Rations for fitting yearlings and mature sheep. Show year- s on full feed will eat about 3 lbs. of grain per head daily, reas mature sheep will eat about 3½ lbs. of grain per head y:

on No. 1

	50 lbs.
(split)	40 lbs.
at bran	10 lbs.

on No. 2

	50 lbs.
ey	40 lbs.
at bran	10 lbs.

Ration No. 3

Corn	40 lbs.
Oats	40 lbs.
Wheat bran	10 lbs.
Protein supplement[2]	10 lbs.

Ration No. 4

Oats	60 lbs.
Peas (split)	10 lbs.
Barley	10 lbs.
Wheat bran	10 lbs.
Protein supplement[2]	10 lbs.

In general, the above rations are higher in protein content n rations used in commercial-fattening operations, but most erienced shepherds feel that by such means they get more om. Showmen prefer to feed steamed rolled oats and barley nutted (pea-sized) linseed oil meal. Corn is usually cracked coarsely ground, and peas are split or cracked. When pastures not available, alfalfa is the most popular hay. But any good ume is quite satisfactory. The lighter types of lamb rations 1, 4, and 5) are usually used for summer feeding, especially en animals are being fitted for the late shows.

[1]Beginning fitting ration used at the State College of Washington. Near end of the fitting period, the Shepherd adds 50 pounds of barley and 50 nds of peas to each 100 pounds of Ration 1.

[2]Linseed, cottonseed, and/or soybean meal.

In fitting animals for show or sale, most successful shepherds feed a limited quantity of sliced carrots, mangels (stock beets), rutabagas (swedes), or turnips. These succulent feeds are highly relished by sheep and appear to help their digestion and general thrift.

The following points also are pertinent in feeding sheep:

1. All classes and ages of sheep should be allowed free access to a double compartment mineral box, with loose salt in one compartment and a mixture of ⅓ salt and ⅔ steamed bone meal in the other.

2. Unless grains are unusually hard, they need not be ground for sheep. The animals prefer to do their own grinding, and the feeds are no more effectively utilized when ground.

CHAPTER XXIII

NTRAL MARKETING AND PACKER SLAUGHTERING OF SHEEP AND LAMBS[1]

Although sheep are marketed through much the same media attle or hogs, the following differences exist:

(1) In general, there is a greater transportation problem, use 83 per cent of the lambs are raised west of the Mississip- nd about 78 per cent of the lamb is consumed east of the sissippi.

(2) Age is a greater factor in determining relative market es of sheep than it is in determining that of cattle and hogs; 95 per cent of the sheep slaughter is from lambs.

(3) More sheep than cattle are marketed direct.

(4) Because of the pelt, the by-products of sheep are more able than are the by-products obtained in cattle or hog ghter.

(5) More sheep and lambs than any other class of animals slaughtered under federal inspection.

(6) Sheepmen take more breeders back to the country do cattle or hog producers.

ADING SHEEP MARKETS

Sheep are marketed by much the same methods as cattle. vith stocker and feeder cattle, direct selling is increasing with ker and feeder sheep. Although Chicago holds undisputed n as the greatest cattle and hog market in the world, Denver e leading sheep and lamb market. The ten largest sheep and markets by rank and their receipts are given in Table 41.

ADING FEEDER SHEEP MARKETS

When the range or pasture is inadequate to produce a fat , the animals must go the feeder route. Feeder lambs are ened out by various methods and in various sections of the ted States. Such feeder lambs are either sold direct or are iged to the central markets.

[1] The author wishes to acknowledge with thanks the many helpful sug- ons of Professor F. I. Dahlberg, Department of Animal Husbandry, cultural and Mechanical College of Texas, College Station, Texas, who wed Chapter XXIII.

TABLE 41

TOTAL RECEIPTS OF TEN LEADING SHEEP AND LAMB MARKETS; AVERAGE 1944 TO 1948, BY RANK 1949[1]

Market	Average 1944 to 1948	1949
Denver, Colorado	2,259,550	1,857,935
Ogden, Utah	1,471,552	1,210,838
Fort Worth, Texas	2,210,840	927,953
Omaha, Nebraska	1,728,325	922,141
Kansas City, Missouri	1,935,443	913,847
Jersey City, New Jersey	1,286,123	829,568
So. St. Paul, Minnesota	1,187,449	745,681
St. Joseph, Missouri	990,380	732,072
Pittsburgh, Pennsylvania	957,081	723,421
Chicago, Illinois	1,454,727	622,862
United States Total[2]	24,901,192	15,843,310

[1] *Livestock Market News, Statistics and Related Data,* 1949, U. S. Dept. of Agri., August, 1950, p. 11.
Ibid., 1947, p. 15.
Livestock, Meats, and Wool Market Statistics and Related Data, 1945, p. 14.
[2] Includes 65 markets.

In-shipments of feeder sheep and lambs at central markets are not recorded, for the reason that it is difficult at the time of receipt of shipments to ascertain whether sheep will go the slaughter route or the feeder route. However, since most feeder

TABLE 42

FEEDER SHIPMENTS FROM TEN LEADING FEEDER SHEEP AND LAMB MARKETS; AVERAGE 1944 TO 1948, BY RANK 1949[1]

Market	Average 1944 to 1948	1949
Denver, Colorado	849,374	687,848
Ogden, Utah	400,577	501,299
Salt Lake City, Utah	100,300	210,244
Omaha, Nebraska	347,890	184,059
Fort Worth, Texas	149,551	178,014
St. Joseph, Missouri	69,552	166,971
So. St. Paul, Minnesota	216,230	166,242
Sioux City, Iowa	203,721	137,425
Kansas City, Missouri	161,257	69,557
Sioux Falls, S. Dakota	61,387	50,124
United States Total[2]	2,485,272	2,673,766

[1] *Livestock Market News, Statistics and Related Data,* 1947, U. S. Dept. of Agri., July, 1948, p. 27.
Ibid., 1949, August, 1950, p. 18.
Quoted as "number inspected at Public Stockyards" for shipment.
[2] Includes 65 markets.

eep and lambs are eventually shipped out from central markets or to being placed on feed, out-shipments from central markets a satisfactory criterion of the rank of central markets in the ndling of feeder sheep and lambs. On this basis, the ten leading der sheep and lamb markets, by rank, are as indicated in ble 42.

ARKET CLASSES AND GRADES OF SHEEP

The market classes and grades of sheep follow closely the ttern for the classes and grades of cattle and swine (See Table . One notable difference is that a sizeable number of sheep e sold as breeders. For the most part, this class is made up of ture western ewes that are sold to country buyers for the rpose of producing one to two more crops of lambs before ain being returned to the market. Usually such ewes can be quired at a lower cost than ewe lambs. In certain sections of e country, many flock rams are acquired on the market, hough no market quotation is given for such breeders and the actice is not considered too sound. Another difference between eep and other species is found in the fact that one feeder class, mely the shearers, is based on wool value as well as adaptability further feeding.

ctors Determining Market Classes of Sheep

The disposition or use to be made of sheep is determined : (1) whether they are sheep or lambs, (2) the use selection,) sex, (4) age, and (5) weight.

EEP AND LAMBS:

The first major market subdivision of the ovine species parates the animals into sheep and lambs. Lambs include those mals that are approximately one year old and under. When ere is any question as to whether animals should be classified sheep or lambs, a final decision is usually based upon an examtion of the teeth. If the first pair of larger, broader permant teeth is about fully developed, the animal is classified as a arling; for this change in the teeth takes place at about twelve nths of age.

At the present time, lambs and yearlings make up approxately 95 per cent of the total sheep slaughter.

E SELECTION OF SHEEP AND LAMBS:

Sheep and lambs are divided into six market groups based the uses to be made of them or the purposes for which they e best suited: slaughter sheep, feeder sheep, breeding sheep,

TABLE 43

MARKET CLASSES AND GRADES OF SHEEP

Sheep or lambs	Use selection	Sex classes	Age	Weight divisions	Pounds	Commonly used grades
Sheep	Slaughter Sheep	Ewes	Yearling	Light	90 down	Prime, Choice, Good, Utility, Cull
				Medium	90 to 100	
				Heavy	100 up	
			Mature (2-year-old or older)	Light	120 down	Choice, Good, Utility, Cull
				Medium	120 - 140	
				Heavy	140 up	
		Wethers	Yearling	Light	100 down	Prime, Choice, Good, Utility, Cull
				Medium	100 - 110	
				Heavy	110 up	
			Mature (2-year-old or older)	Light	115 down	Choice, Good, Utility, Cull
				Medium	115 - 130	
				Heavy	130 up	
		Rams	Yearling	All Weights		Choice, Good, Utility, Cull
			Mature (2-year-old or older)	All Weights		Choice, Good, Utility, Cull
	Feeder Sheep	Ewes and Wethers	Yearlings	All Weights		Fancy, Choice, Good, Medium, Common
		Ewes	Mature (2-year-old or older)	All Weights		Choice, Good, Medium, Common, Inferior
	Breeding Sheep	Ewes (rams occasionally purchased as breeders, but not listed in market reports)	Yearlings, 2, 3, or 4 yr. olds and older	All Weights		Fancy, Choice, Good, Medium, Common
Lambs	Slaughter Lambs	Ewes, Wethers and Rams	Hothouse lambs	60 down		Prime, Choice, Good, Utility, Cull
		Ewes, Wethers and Rams	Spring lambs	Light	70 down	Prime, Choice, Good, Utility, Cull
				Medium	70 - 90	
				Heavy	90 up	
		Ewes, Wethers and Rams	Lambs	Light	75 down	Prime, Choice, Good, Utility, Cull
				Medium	75-95	
				Heavy	95 up	
	Feeder Lambs	Ewes and Wethers	All Ages	All Weights		Fancy, Choice, Good, Medium, Common, Inferior
	Breeder Lambs	Ewes and Wethers	All Ages	All Weights		Choice, Good, Medium

ghter lambs, feeder lambs, and shearer lambs. A brief de-
ɔtion of each of these classes follows:

Slaughter Sheep.—Yearlings or older animals intended for
ediate slaughter.

Feeder Sheep.—Yearlings or older animals best suited for
ner fattening.

Breeding Sheep.—Largely mature western ewes that are
rned to the country for further reproduction. In addition to
ket grade in considering the suitability of ewes for breeding
oses, it is important that attention be given to the condition
he teeth and the breed, health, and general potentialities
breeder.

Slaughter Lambs.—Young animals under one year of age
are sufficiently fat for immediate slaughter.

Feeder Lambs.—Young animals under one year of age that
y insufficient finish for slaughter purposes but which show
ations of making good gains if placed on feed.

Shearer Lambs.—Those intended for shearing and further
ening prior to slaughtering. This classification is of impor-
e on certain markets during the late winter and early spring
ths. Typical shearer lambs carry nearly a full year's growth
ool, but they are not fat enough to be market-topping slaugh-
ambs. Such lambs are usually shorn out and fattened before
rning to the market. The term "shorn lamb" is used to desig-
those lambs that have had their fleece removed within sixty
prior to marketing. Those fed lambs that have not been
n are usually differentiated from "shorn lambs" by adding
term "wooled" to the class name.

SEX CLASSES:

The sex classes for sheep and lambs are: ewes, wethers, and
s. At the lamb and yearling stage, ewes and wethers are
lly suitable for slaughter purposes. Ram lambs are usually
ewhat discounted in price, and they are almost never used
feeder purposes. A definition of each sex class follows:

Ewe.—A female sheep or lamb.

Wether.—A male ovine animal that was castrated at an
y age, before reaching sexual maturity and before developing
physical characteristics peculiar to rams.

Ram.—An uncastrated male ovine animal of any age. The
n "buck" is sometimes applied to animals of this sex class.

AGE GROUPS:

Each of the major age divisions is further separated into more exacting age groups. Thus mature sheep may be designated as yearlings, two-year-olds, three-year-olds, four-year-olds, or mature sheep. Yearlings are much more acceptable for slaughter purposes than mature sheep.

In a general way, age groups in lambs are indicated by the terms hothouse lambs, spring lambs, and lambs. Each of these age groups may be described briefly as follows:

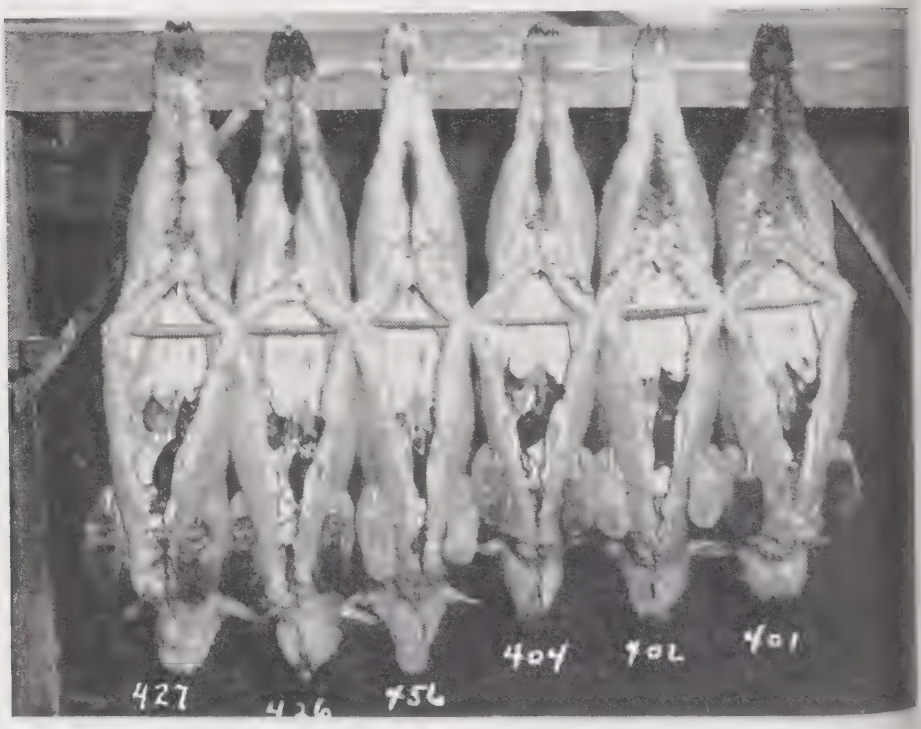


Fig. 247. Hothouse lambs "hog dressed" (meaning head and pelt off but front feet and viscera removed). The method holds shrinkage to a min imum and maintains a pink carcass color in young lambs. The pluck is left in. (In this case, the pluck consists of the liver, heart, lungs, gullet, and windpipe.) (Courtesy, P. T. Ziegler, Pennsylvania State College.)

Hothouse lambs.—Very young lambs—usually less than three months of age at slaughter—which are born and marketed out of season. Such milk-fat lambs are usually marketed during the period from Christmas to the Easter holidays at weights ranging from 30 to 60 pounds. Hothouse lambs may consist of ewe, wether, or ram lambs. Although sex class is unimportant these lambs must be undocked if sold on the Boston market.

Spring lambs.—New-crop lambs arriving at the market in the spring of the year. Usually these are lambs born in the late

ıe early winter and marketed prior to July 1. After July 1 ıals of like birth are simply designated as "lambs" on the ket. The most desirable spring lambs range from three to n months in age and weigh from 70 to 90 pounds. Because ıe young age, sex class is unimportant in spring lambs— may be ewe, wether, or ram lambs.

Lambs.—All young ovine animals that do not classify as er hothouse or spring lambs. This is by far the most numer- class of market sheep under one year of age. These animals usually born in the late winter or spring of the year and are keted at seven to twelve months of age. In general, they ist on milk and grass. Lambs fed grain prior to marketing designated as "fed lambs" in order to differentiate them ı "lambs."

Yearlings.—Young sheep between approximately one and years of age. They may be identified by the fact that they e cut their first pair of permanent incisor teeth but not the nd pair.

Two-year-olds.—Sheep that are between twenty-four and ty-six months old and which have cut their second pair of ıanent incisor teeth.

Three-year-olds.—Sheep that are between thirty-six and y-eight months old and which have cut their third pair of ıanent incisor teeth.

Four-year-olds.—Sheep that are between forty-eight and y months old and which have a full set of permanent incisors.

Mature sheep.—Usually animals that are two-years-old or . With further age and the loss of teeth, they are referred s "broken-mouthed." If all the incisors are missing or worn n to the gums, they are known as "gummers." If the teeth long and spread apart at the surface, the ewes are called eaders." All gummers and broken-mouthed ewes should be cted in buying breeding sheep, for such animals are not likely old up in flesh on winter feeds.

IGHT DIVISIONS:

Weight is an especially important price factor in the case ambs. As a rule, heavy lambs (90 pounds and up) are in less ıand on the market than lighter-weight animals of similar le. This is largely due to the consumer preference for small- medium-sized cuts of lamb. Thus, weight is an important ıor in both feeder and slaughter lambs. Heavy, fat ewes usual-

ly sell at a discount; they are not considered desirable for either slaughter or breeding purposes.

The Market Grades of Sheep and Lambs

Based on conformation, finish, and quality, slaughter sheep and lambs are graded as Prime, Choice, Good, Utility, or Cull.[1] The corresponding grades of feeder sheep and lambs are: Fancy, Choice, Good, Medium, Common, and Inferior. The grades of breeder ewes are like those of feeders, except that the Inferior grade is omitted.

While no official grading of live animals is done by the U.S. Department of Agriculture, these grades do form a basis for uniform reporting of livestock marketings.

OTHER SHEEP MARKET TERMS AND FACTORS

In addition to the rather general terms used in designating the different market classes and grades of sheep, the following terms and factors are frequently of importance:

Native and Western Sheep

"Native sheep" are predominately of mutton breeding and are produced in the central, eastern, and southern states, in the mixed farming areas. "Westerns" are predominately of grade Rambouillet breeding or Rambouillet X mutton breed crossbreds that come from the western ranges. In the case of western sheep, their state of origin is frequently used as a designation rather than the broad classification as "westerns."

"Whiteface" and "Blackface" Sheep

"Whiteface" and "blackface" are sometimes used to designate the general type and breeding of sheep and lambs. In general "whiteface" sheep and lambs are predominately of fine-wool breeding and do not possess quite the blockiness and general excellent mutton conformation of the "blackface" sheep. "Blackface" sheep are either predominately of mutton breeding or are sired by a blackfaced ram of one of the mutton breeds.

[1]Effective April 30, 1951, the Medium and Common grades were dropped, the Prime and Choice grades were combined and designated as Prime, the Good grade was renamed Choice, the upper two-thirds of the Medium grade was renamed Good, the lower one-third of the Medium and the upper two-thirds of the Common were renamed Utility, and the lower one-third of the Common grade and all of the Cull grade were combined under the Cull designation.



Fig. 248. Market grades of slaughter lambs. Names changed to con-
n to new U.S.D.A. grades, as interpreted by the author. (Courtesy,
.D.A., Production and Marketing Administration.)

Discounting Long-Tailed and Ram Lambs

All market lambs from commercial flocks should be docked and castrated at an early age. Long-tailed and "buck" lambs are frequently docked up to $2.00 and $3.00 per hundredweight on a discriminating market. Thin lambs, which should go the feeder route, are discounted more than slaughter animals. Despite the dock in price of ram lambs that are subsequently culled out and marketed for slaughter, purebred breeders can often afford to retain all male lambs as rams until weaning age, at which time more intelligent selections may be made. Of course, this can only be justified when some of the ram lambs are valuable for breeding purposes.

Value of the Pelt in Market Sheep

When wool prices are good, the degree of desirability of the pelt is a factor of importance in determining the price of market sheep and lambs.

PACKER SLAUGHTERING AND DRESSING OF SHEEP AND LAMBS

Table 44 shows the proportion of sheep and lambs dressed in federally inspected plants. The total figure refers to the number dressed in all establishments and on farms.

TABLE 44

PROPORTION OF SHEEP AND LAMBS SLAUGHTERED IN FEDERALLY INSPECTED PLANTS, 1945 to 1949[1]

Year	Sheep and Lambs	
	Slaughtered under federal inspection	Total
	1,000 Head	1,000 Head
1945	21,220	24,642
1946	19,897	22,814
1947	16,666	18,766
1948	15,343	17,43[illegible]
1949	12,137	13,872

[1] *Livestock Market News, Statistics and Related Data*, 1947, U. S. Dept. of Agri., July, 1948, p. 52.
Ibid., 1949, August, 1950, pp. 24 and 33.

Whether sheep are slaughtered in a large federally inspected packing plant, in a small local slaughtering house, or on the farm, the slaughtering procedure is much the same. Because most sheep are slaughtered in the larger packing plants rather than on farms, only packer slaughtering procedure will be discussed.

In order to avoid undue excitement and make for ease in ling, gregarious sheep and lambs are usually led to the ers' slaughtering pens by an old goat, commonly referred "Judas." A reasonable fast and quiet prior to slaughtering specially important for sheep.

s in Slaughtering and Dressing Sheep and Lambs

The endless chain method is used in sheep slaughter. The s in packing house slaughter procedure are as follows:

1. **Shackling and hoisting.**—The animals are driven into all shackling pen; a shackle is placed around the hind leg above the foot; and the animals are delivered to an overhead by means of a wheel hoist.

2. **Bleeding.**—A double-edged knife is inserted into the just below the ear so that it severs the large blood vessel ne neck.

3. **Removal of feet.**—After bleeding, the front feet are oved. Lambs and most yearlings will break at the "break-" or "lamb-joint," a temporary joint characteristic of young p which is located immediately above the ankle. In dressing ure sheep, the front feet are removed at the ankle, leaving und joint on the end of the shank bone.

4. **Removal of pelt.**—The pelt is next removed. Caution is n to prevent damage to the fell (the thin, tough membrane ring the carcass immediately under the pelt.)

5. **Removal of hind feet and head.**—Next the hind feet and l are removed.

6. **Opening of carcass and eviscerating.**—The carcass is ed down the median line; the internal organs, windpipe, and et are removed; and the breast bone is split. The kidneys are intact.

7. **Shaping.**—The forelegs are folded at the knees and are in place by a skewer. A spread-stick is inserted in the belly llow for proper chilling and to give shape to the carcass.

8. **Washed.**—Finally the carcass is washed, wiped, and mptly sent to the cooler. Some of the better-grade carcasses wrapped in special coverings for marketing.

"Break-Joint" or "Lamb-Joint"

In general, the packer classes as "lamb" all carcasses in ch the forefeet are removed at the "break-joint" or "lamb-t." This joint—which can be severed on all lambs, most

yearling wethers, and some yearling ewes (ewes mature earlier than wethers or males)—is a temporary cartilage located just above the ankle. In lambs, the break-joint has four well-defined ridges that are smooth, moist, and red. In yearlings, the break-joint is more porous and dry. In mature sheep, the cartilage is knit or ossified and will no longer break, thus making it necessary to take the foot off at the ankle instead. This makes a "round-joint" (commonly called "spool-joint"). All carcasses



Fig. 249. The two types of joints of the foreleg of a sheep: A, the "break-joint" or "lamb-joint," and B, the "round-joint" or "spool-joint." Arrow indicates the location of the break-joint or ossification. All carcasses possessing the round-joint are sold as mutton rather than lamb. **(Courtesy, U.S.D.A.)**

essing the "round-joint" are sold as mutton rather than
).

Dressing Percentage

In order to yield a high percentage of carcass, sheep must
1) light in pelt, (2) well finished and heavily muscled, and
free from paunchiness. Because of the higher value of the
of sheep, especially the high value of the pelt, a high dress-
percentage in sheep is not so important as in cattle or hogs.
act, the wool is usually worth more per pound than the
ass of mutton or lamb. Wool yield, therefore, is usually an
ortant item in slaughter return, and dressing return, and
sing percentage lowered by heavier wool yield may actually
n a greater total return. For this reason, the fleece should
s heavy as is consistent with the production of mutton or
of high quality.

Sheep and lambs range in dressing percentage from 35 to
er cent with an overall average of 47 per cent. As would be
ected, the highest dressing percentage is obtained when
nals are slaughtered following shearing. Prime- and Choice-
le yearlings with the proper twenty-four-hour shrink will
s from 55 to 61 per cent; whereas fat lambs of comparable
le will average about 2 to 3 per cent lower. Lambs of the
ton breeds yield a somewhat higher percentage of carcass
n those of the so-called wool breeds. The offal and by-products
n slaughter of sheep and lambs consists of the blood, pelt,
, head, and viscera.

The average live weight of sheep and lambs dressed by
mercial meat packing plants and their percentage yield in
t for the ten-year period, 1938 to 1947, was as follows:[1]

	Average live weight (in pounds)	Average yield in meats (in pounds)	Dressing percentage
ep and lambs	89.6	41.4	46.2

NG LAMB AND MUTTON

Prime and choice lamb and mutton carcasses are best if aged
e or four weeks. On the other hand, the medium and plain
casses carrying less fat should be merchandized a few days
r slaughter.

[1] *Livestock Market News, Statistics, and Related Data*, U. S. Dept. of
., 1948, pp. 78 and 79.

DISPOSITION OF THE LAMB AND MUTTON CARCASS

For the most part, lamb and mutton carcasses are sold to the retailers fresh and as entire carcasses rather than as wholesale cuts. On the other hand, some wholesale cuts are prepared in the packing plants, thus making it possible to meet the greater demands of certain areas for specific cuts.

A small amount of lamb and mutton is frozen and held for future market, but the consumers in this country have never accepted frozen lamb and mutton to the same degree as the British.

Lamb and mutton may be cured by the ordinary methods employed in curing pork. The curing of lamb and mutton requires somewhat less time because of the comparatively smaller cuts. Legs of lamb that have been cured and smoked—known as "lamb hams"—are very similar to pork hams in color and flavor. One of the main objections to cured and smoked lamb is that it dries out rapidly. For this reason, only a very small amount of lamb and mutton is cured in this country.

Carcasses or wholesale cuts that are not considered desirable for the trade, or for which there is not sufficient demand, are processed at the packing plant. Eventually they are sold as "prepared meats" and "meat food products."

THE LAMB AND MUTTON CARCASS AND ITS CUTS

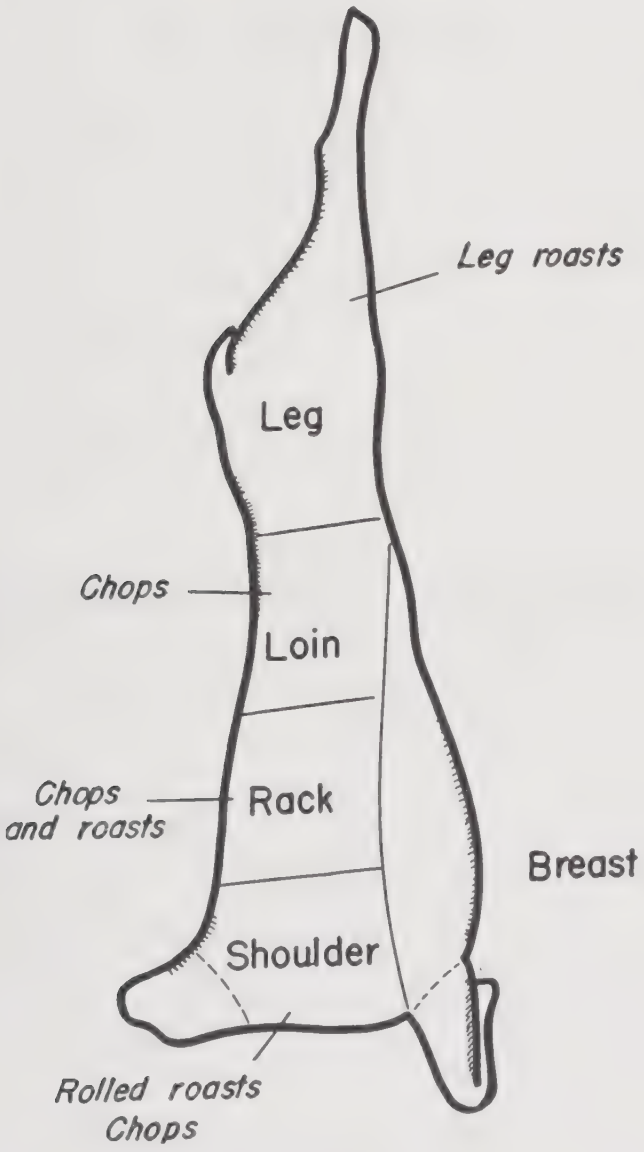
The two major wholesale cuts of lamb and mutton are the (1) hind saddle, and (2) fore saddle. The division into hind and fore saddle is made between the twelfth and thirteenth ribs, with one pair of ribs remaining on the hind saddle. Each of these two larger cuts comprises about 50 per cent of the carcass weight.

The hind saddle is further subdivided into the legs and loins. The fore saddle is subdivided into the rack (or hotel rack), shoulder, and breast.

GOAT MEAT (CHEVON)

Goat meat is sold under the trade name of "Chevon," although in those areas where goat production is relatively important, it is suspected that some retail shops occasionally substitute it for the lower grades of lamb or mutton. Without doubt, however, most goat meat is put into processed meats. It is a perfectly wholesome food, though lacking in the blocky conformation and degree of finish possessed by the better grades of

and mutton. Chevon from older goats is likely to possess rong flavor. Only a limited number of goats are slaughtered neat.



Lamb

Fig. 250. Wholesale cuts of lamb and some of the common retail cuts. etimes the carcass is divided between the twelfth and thirteenth ribs (1) the hind saddle (including the leg and loin), and (2) the fore le (including the rack, shoulder, and breast). (Drawing by R. F. John-

CHAPTER XXIV

WOOL AND MOHAIR[1]

Sheep yield two products—lamb or mutton and wool, with the relative emphasis on each varying according to the remuneration derived therefrom. This same thinking applies wherever mutton and lamb are produced, which is throughout the world.

Despite the larger income from lamb under certain conditions, practical sheepmen everywhere recognize the fact that the fleece represents certain income, whether a lamb is produced or not. Accordingly, they select ewes and rams with long, dense fleeces of uniformly good quality and reject those individuals having fibers of any color other than white or those with hairy, loose, or extremely open fleeces. No balance statement will ever alter the importance of wool as one of the world's greatest textile materials. Since the dawn of history, the wool of sheep, the natural function of which is to protect and conserve the warmth of the animal's body, has been used by the human race. Although its chief use has been, and still is, for clothing, it is widely used for blankets, upholstery, carpets, felts, and numerous other products in industry.

It is noteworthy that for the period 1910 to 1949 the income to U. S. sheep raisers from wool, including the value of pulled wool, was equivalent to 49.4 per cent of the total income from sheep, lambs, and wool. The income from shorn wool comprised 38.3 per cent of the total income, and 11.1 per cent was attributable to pulled wool.[2] Of course, if the value of pulled wool is excluded (which is not too logical), about 40 per cent of the total income to sheepmen is derived from wool and 60 per cent from sheep and lambs.

[1] In the preparation of this chapter, the author has drawn heavily from Massachusetts State College Extension Leaflet 179, by M. E. Ensminger and James H. Kennedy, Jr. Also, the author is deeply indebted to the following authorities who reviewed this chapter: Professor James H. Kennedy, Jr., Lowell Textile Institute, Lowell, Massachusetts; Mr. C. J. Fawcett, General Manager, National Wool Marketing Corporation, Boston, Massachusetts; and Professor J. M. Jones, Chief, Division of Range Animal Husbandry, Agricultural and Mechanical College of Texas, College Station, Texas.

[2] Domestic wool Requirements and Sources of Supply, U. S. Dept. of Agri., Production and Marketing Administration and Bureau of Agricultural Economics, June, 1950, p. 25.

The discussion that follows is designed to bridge the gap
een the wool producer and the manufacturer. Although each
his particular problems, both are working toward a common
The producer breeds, feeds, and manages his flock to supply
raw material; whereas the manufacturer scours, combs,
, and weaves the fiber into cloth.

OL IS THE NATURAL CLOTHING OF SHEEP

With all the perfection and modification in the fleece that
been wrought through centuries of domestication, breeding,
tion, and improved environmental conditions, it must not
rgotten that wool is the natural hair as well as clothing of
p. A covering of hair or feather performs a thermo-regula-
function for warm-blooded animals, the original intent being
otect its growers from heat or cold. As wool fibers are poor
uctors of heat, they serve to prevent any abnormal loss of
from the body.

In the wild state, sheep carried two distinct coats. The outer



ig. 251. Wool is the natural clothing of sheep. The Merino ram pic-
is a member of the breed that produces the world's finest wool. (Cour-
International Wool Secretariat.)

or protective coat consisted of long, coarse fibers, which today are classed as hairs (known as "kemp"). The undercoat of the wild sheep was soft and curly and provided the necessary warmth for the animal.

It is interesting to note that the relative development of these two coats varied with the climatic conditions under which the animals lived.

Unfortunately, up to the present time, breeding has not banished the coarse fibers entirely, for they are still evident in most breeds of sheep. This is particularly obvious in the Scotch Blackface sheep, one of the present breeds most closely related to the primitive type. However, since the days of mythology, when wool was rightfully called the "Golden Fleece," sheep breeders everywhere have recognized that the elimination of black hairs, kemp, and other undesirable features must be accomplished in order to produce a fleece of the highest economic value and utility to mankind.

Domestication and proper cultivation have resulted almost exclusively in the production of "true wool," with but little or none of the hairy fiber remaining. Even so, the exact character of the wool on the individual sheep varies considerably, according to its position on the body. For example, in the region of the lower britch, the wool becomes coarse and hairy; and near the feet, a short undergrowth of stiff hair is found. Too many sheep seem to produce a limited number of short, stiff fibers or undergrowth over the entire body area. These short fibers have no value as textile fibers.

VIRTUES OF WOOL

It is noteworthy that the unique characteristics and virtues of wool have, through the years, enabled it to hold its position of prominence in competition with other animal fibers, products of plant origin, and the invasion of innumerable synthetic materials. Although certain other fibers may equal or even excel in one or several qualities, none can boast of the total qualities possessed by wool. The virtues of wool are as follows:

1. Wool is porous and will absorb water more readily than any other textile fiber. It can absorb as much as 18 per cent of its own weight in moisture without even feeling damp and up to 50 per cent of its weight without becoming saturated. This is an important health factor in clothing because body perspiration and outer dampness are prevented from clinging to the body in heat or cold, thus removing the chill line from the body.

2. Wool generates heat in itself.
3. Wool is a superior insulator, keeping the heat of the body escaping and the cold air from entering. Because of this ty, wool is as effective as a protection from tropical heat sun as it is against the gale-driven storms of winter.
4. Wool is light.
5. Wool is very elastic; the average fiber will stretch 30 cent of its normal length and still spring back in shape. use of this resilience, wool garments resist wrinkling, ching, or sagging during wear.
6. Wool transmits the health-giving ultra-violet rays.
7. Dyestuffs are less liable to fade and are faster on wool.



Fig. 252. From 85 to 90 per cent of the wool manufactured in this ry is used for clothing and only 10 to 15 per cent for industrial pur-. The picture shows a wool suit. (Courtesy, The Wool Bureau, Inc.)

8. Wool is durable.

9. Wool is strong. Diameter for diameter, a wool fiber is stronger than steel.

10. Wool is almost noninflammable. It will stop burning almost as soon as it is taken away from a flame.

11. Wool can be felted or matted easily.

USES OF WOOL

Exclusive of carpets and rugs, it is estimated that from 85 to 90 per cent of the wool manufactured in this country is used for clothing and only 10 to 15 per cent for industrial purposes (chiefly automobile cloth and blankets). By contrast, in the cotton industry, 45 per cent of the goods are used for industrial purposes and another 25 per cent for household purposes.

MAGNITUDE OF THE U. S. WOOL AND TEXTILE INDUSTRY

It is noteworthy that approximately 500,000 persons are engaged in sheep raising. As shown in Table 45, the farmers and ranchers of the United States have long received over 100 million dollars annually for their wool clip. In 1949, a total of 216,950,000 pounds of shorn wool produced in this country sold for an average of 49.3 cents per pound, or a total of $106,963,000. But this did not include additional pulled wool, nor does it tell the story relative to the huge imports. Table 46 gives the wool production, exports, imports and mill consumption, and imports of carpet wool and production of mohair in the United States from 1920 to 1949. As will be noted, in 1947, 60.1 per cent of the total con-

TABLE 45

QUANTITY AND VALUE OF WOOL PRODUCED IN THE UNITED STATES, AVERAGE 1935-44, AND ANNUAL 1945 TO 1949[1]

	Shorn wool produced	Price per pound	Cash value
Average	(Pounds)	(Cents)	
1935-44	365,748,000	30.8	$112,829,000
1945	307,949,000	41.9	129,122,000
1946	280,487,000	42.3	118,395,000
1947	252,798,000	42.0	106,052,000
1948	233,924,000	48.8	114,072,000
1949	216,950,000	49.3	106,963,000

[1] *Agricultural Statistics*, 1947, U. S. Dept. of Agri., 1948, p. 355.
Ibid., p. 391.
Livestock Market News, Statistics and Related Data, 1949, U. S. Dept. of Agri., August, 1950, p. 77.

tion of combing and clothing wools used by U. S. mills was rted. In addition, most all of the carpet wools were imported. It is noteworthy that textiles for clothing and household onsume about one-sixth of the income of the average Ameri- amily. In addition to the indispensability of its product, the textile industry is nationally important because it is one e largest industries of the United States. According to the us of Manufacturers, the woolen and worsted manufacturing stry ranks seventh in the number of wage earners employed,

TABLE 46

UCTION, EXPORTS, IMPORTS, AND MILL CONSUMPTION OF ING AND CLOTHING WOOL; IMPORTS OF CARPET WOOL; AND ODUCTION OF MOHAIR IN THE UNITED STATES, 1920-1949[1]

	Wool						
	Combing and Clothing						
	Production	Total domestic exports[2]	Imports less re-exports[2]	Mill Consumption[3]		Carpet, imports, less re-exports	Mohair production[4]
				Total	percent domestic		
	(1000 lbs.)	(1000 lbs.)	(1000 lbs.)	(1000 lbs.)	%	(1000 lbs.)	(1000 lbs.)
.....	293,788	8,845	207,419	510,900	51.3	35,093	8,566
.....	290,223	1,927	217,233	597,400	63.6	97,820	9,461
.....	270,367	453	189,486	640,400	72.3	172,828	8,589
.....	272,668	535	243,270	603,100	51.7	121,518	9,183
.....	282,005	309	94,495	518,000	69.2	140,684	9,986
.....	300,003	273	171,980	525,200	69.5	157,579	11,146
.....	318,861	292	170,142	524,100	66.0	115,235	12,803
.....	339,504	323	109,850	551,100	75.7	143,871	13,960
.....	366,720	485	87,132	511,900	82.9	148,794	15,956
.....	382,295	239	100,352	554,700	80.2	174,483	16,736
.....	414,029	162	70,135	447,900	81.2	90,621	17,583
.....	442,401	274	42,915	545,200	89.6	113,795	19,376
.....	418,096	179	13,522	439,800	95.0	39,195	16,935
.....	438,352	19	59,341	572,200	94.0	114,468	16,539
.....	429,360	119	29,258	381,400	90.4	79,084	16,182
.....	427,531	20	41,984	748,400	94.8	158,477	15,720
.....	419,411	16	110,712	666,400	83.6	143,276	16,124
.....	422,278	68	150,160	579,500	72.7	172,091	16,528
.....	424,425	1,343	30,812	513,900	92.5	71,908	16,827
.....	426,189	179	98,194	673,900	88.0	144,875	18,785
.....	434,014	456	222,983	683,300	77.1	134,691	21,144
	453,320	38	613,566	1,021,500	52.2	203,249	21,766
	454,997	111	782,647	1,125,571	51.2	72,017	20,676
	444,043	27,924	642,887	1,112,836	41.7	33,489	20,156
	411,818	7,476	581,848	1,054,697	32.6	34,775	20,467
.....	378,449	28,797	724,953	1,058,374	26.2	79,521	22,038
.....	341,787	16,008	923,814	1,098,538	23.3	125,418	19,329
	309,398	12,720	528,172	1,021,206	39.9	112,120	18,476
.....	280,524	1,154	596,466			160,634	16,591
.....	253,350	15,801	347,945			86,621	

Livestock Market News, Statistics, and Related Data, 1949, U. S. of Agri., August, 1950, p. 78.
Hair of angora goat, alpaca, and other like animals included.
Greasy shorn basis.
From seven leading mohair producing states.

twelfth in the value of materials used, and fourteenth in dollar value of sales. The only groups employing more wage earners are (1) the automotive industry, (2) steel, (3) cotton fabrics, (4) sawmills, (5) footwear, and (6) bread and bakery products.

THE WOOL FIBER

Wool is the natural protective covering of sheep. It differs from other animal fibers by having a serrated surface; a crimpy, wavy appearance; an excellent degree of elasticity; and an internal structure composed of numerous minute cells. In contrast, hair has a comparatively smooth surface, lacks in crimp or waviness, and will not stretch. As a product of the skin or cuticle of vertebrate animals, wool is similar in origin and general chemical composition to the various other skin tissues found in animals—such as horn, nails, and hoofs.

The Three Cell Layers

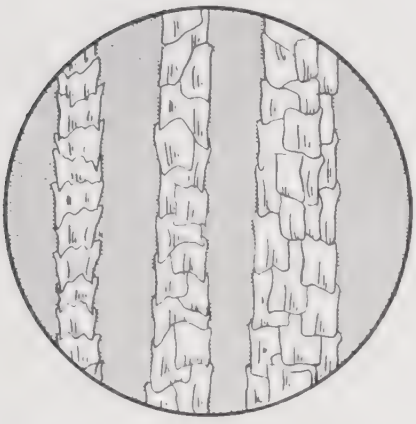
From the standpoint of structure, a microscope reveals that all wool fibers consist of two distinct cell layers, and some fibers have a third layer. According to their positions, these layers are known as (1) the epidermis or outer layer, (2) the cortex, and (3) the medulla. Although differing in characteristics, these same three cell layers are found in most hair. The chief characteristics of these three layers in wool fibers will be discussed briefly.

THE EPIDERMIS:

The epidermis, which is the outside or surface layer of the fiber, is made up of flat, irregular horny cells or scales. These scales overlap one on top of the other much like the scales of a fish, with the free end projecting outward and upward toward the tip of the fiber in such fashion as to present a serrated appearance. Fine wool has many more serrations per inch than coarse wool. They run from 600 to the inch in the low grades of wool up to 3,000 to the inch in the finest of Merino wools. The epidermal cells impart spinning and felting qualities to wool.

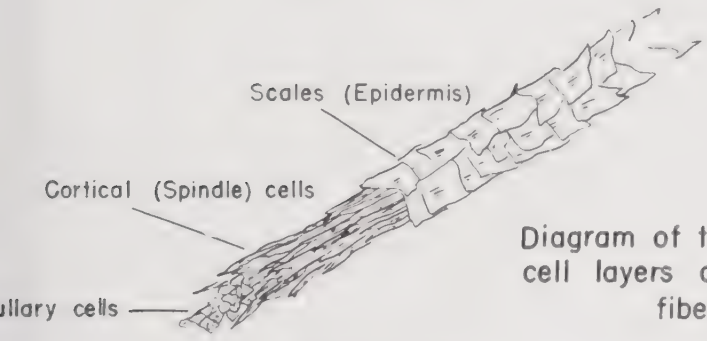
THE CORTEX:

This cell layer, which constitutes the principal body of the wool fiber, lies immediately below the epidermis. It is made up of long, flattened, more or less twisted, spindle-like cells. The cortical cells impart strength and elasticity to the fiber, and some workers believe that they are responsible for crimp, although the latter point appears to be debatable.



Magnified Wool Fibers

Fine Medium Coarse



ig. 253. Diagram showing the structure of wool fibers. Upper picture the epidermis—the outside cell layer—of fine, medium, and coarse Note that fine wool has a greater number of serrations. Bottom e shows the three cell layers (1) the scales or epidermis, (2) the cor- nd (3) the medulla. (Drawing by R. F. Johnson.)

MEDULLA:

Although usually absent in fine wools, most medium and se wools possess a third cell layer known as the medulla. re present, this is the innermost layer. The cells are of vari- shapes, often polygonal like a honey-comb; and they may r occur throughout the length of the fiber or be restricted rtain areas. Wool fibers containing medulla are not desirable, ng the working properties of nonmedullated fibers. Such s are generally coarse, uneven in diameter, and harsh to the n.

nical Composition of Wool

Chemically, wool is chiefly keratin, which is also the primary tituent of hair, nails, hoofs, horns, and feathers. Keratin

is a mixture of nitrogen and sulphur compounds and amino-acids. A typical chemical breakdown of wool is as follows: carbon, 50 per cent; oxygen, 22 to 25 per cent; nitrogen, 16 to 17 per cent; hydrogen, 7 per cent; and sulphur, 3 to 4 per cent.

SOME FLEECE CHARACTERISTICS

The chief fleece characteristics of interest and importance to both the producer and manufacturer are: (1) grease, (2) length, (3) density, (4) diameter and (5) variations of different body areas.

Grease

In a broad sense, grease refers to all the impurities found in unscoured wool, including the yolk, suint, and soluble foreign matter but not the vegetable matter. Shrinkage of fleeces varies widely, with many factors affecting it, but on the average, U. S. shorn grease wool shrinks about 55.5 per cent.

The commercial value of a clip of wool is largely determined by the amount of clean wool fiber that it yields. Although a part of the impurities found in grease wool are essential for the growth and well-being of the fleece and the animal, the manufacturer is primarily concerned with securing the highest possible yield of clean wool of the finest quality. In the raw state, grease wool contains the following type of impurities:

1. **Natural impurities** which result from the glandular secretions. This includes the yolk and suint. The yolk, which is a mixture of a number of materials of which the principal one is cholesterol, appears to protect the fiber against the detrimental action of the weather. When scoured out and purified, as lanolin, the yolk is used in making ointments, cosmetics, leather dressing, rope, and in rust preventives. In cosmetics, in which form it retails at a very high price, few people are aware that it was derived from a sheep's back. Suint is mixed with the yolk, but it can be readily dissolved out by water. It consists primarily of potassium salts of various fatty acids and smaller amounts of sulphates, phosphates, and nitrogenous materials. Suint, which results from sweating, seems to be the source of the distinctive odor associated with sheep.

2. **Acquired impurities** which are picked up by the animal. They include such mineral impurities as dust, sand, and dirt; vegetable materials consisting of straw, burs, twigs, and grasses; and "dung."

. **Applied impurities** including such identifying substances
's and paints and the residues of dips and sprays.

th

The length of the wool in a fleece is a matter of much impor-
to both the producer and the manufacturer. Together with
ty, it constitutes the principal basis of classification and
ng in buying and selling and largely determines the use to
wool will be put. The wool producer regards good length
desirable attribute, for it gives a greater weight of wool.
dging sheep, fiber length is based on an appraisal of the
l growth as determined by parting the fleece at three body
—the shoulder, side, and britch. Fiber length varies any-
e from one to twenty inches.

ity

Density refers to the closeness or compactness of the fibers
leece and is often defined as the number of fibers per unit
of skin. Experimental studies have revealed very clearly
density differences exist between breeds, individuals, and
areas. It has been estimated that the number of wool fibers
nimal varies from a low of about 16,000,000 for some indi-
ls of the medium or coarse-wool breeds to a high of
00,000 fibers for individuals of the Australian Merino breed.
e density is an attribute in determining fleece weight. In
ng, fleece density is determined by grasping the wool of the
o feel its fullness and compactness and by parting the fleece
amine the apparent closeness of the fibers. Experimental
nce shows that often this method is misleading, apparently
affected by the grease and dirt content.

eter

The fineness of wool is very important because the character
e yarns and fabrics produced is determined to a very great
t by the variations in the diameter of fiber. Wool sorting is
on fineness of fiber, and this is considered to be the sound-
asis on which wool and top qualities can be classified. In the
, the experienced wool man is able to estimate the fineness
sual inspection and handling. It is a well known fact, how-
that an ordinary sample of wool that is estimated by a wool
as representing a certain fineness will, on close examination,
lly show two or three other finenesses. That is, it is really
mposite mixture. If placed under a microscope, it is also
d that the shape or contour of fibers varies greatly. As a



Fig. 254. Photomicrograph of cross section of wool fibers. This small sample is rather typical of the variation in both fineness and shape or contour of fibers. (Photomicrograph by M. E. Ensminger.)

rule, fibers are irregular and possess varying degrees of ovality or ellipticity.

In judging sheep, the number of crimps is usually accepted as an index of fineness; that this is a good criterion is borne out by experiments in which more refined techniques have been used. The diameter of wool fibers varies anywhere from 0.0008 to 0.002 inch and the number of crimps from 5 to 36 per inch.

Variations On Different Body Areas

It is well recognized that there are wide differences between breeds and individuals in such wool characters as fineness, length, density, and yield. In extensive studies that the writer conducted at the University of Massachusetts, using the Shropshire and Southdown breeds, it was found also that there are wide differences in wool characteristics between different body areas. On the basis of these investigations, it appears possible to reduce the wool character distribution of body areas to a common plan with rankings from the most desirable to the least desirable character attribute as shown in Fig. 255 and herewith summarized:

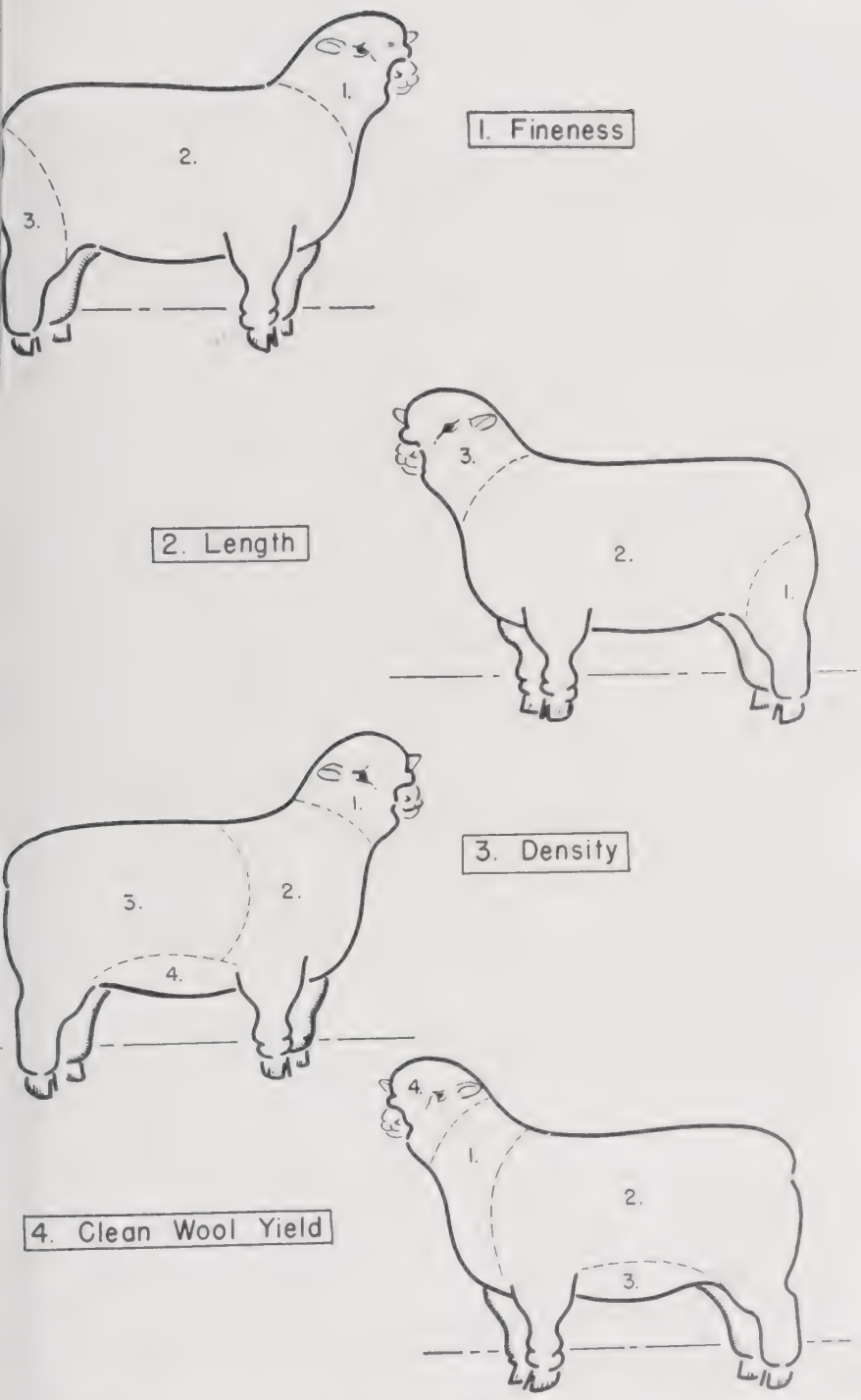


Fig. 255. Diagrams showing variations of different body areas in wool ness, length, density, and clean wool yield; based on results obtained by author in studies with animals of the Shropshire and Southdown breeds ublished data, University of Massachusetts.) On the basis of these in- igations, it appears possible to reduce the wool character distribution ody areas to a common pattern, with rankings of each character from desirable to least desirable. Thus, as shown, the head wool is the t, whereas the britch wool is the coarsest; but the britch wool is the est, whereas the head wool is the shortest. From the standpoint of sity, the head wool ranks at the top of all body areas, but from the dpoint of yield it is the lowest. (Drawing by R. F. Johnson.)

1. **Fineness.**—Three groupings of wool fineness, with rankings from finest to coarsest: (1) the head wool, (2) the dominant or bulk wool over the body generally, and (3) the rump and britch wool.

2. **Length.**—Three groupings of fiber length, with rankings from longest to shortest: (1) the lower britch wool, (2) the dominant or bulk wool over most of the body, and (3) the head wool.

3. **Density.**—Four groupings of fiber density, with rankings from most dense to least dense: (1) the head wool, (2) the neck and shoulder wool, (3) the dominant or bulk wool over most of the body, and (4) the belly wool.

4. **Clean wool yield.**—Four groupings of yield, with rankings from highest per cent yield to lowest per cent yield: (1) the neck wool, (2) the dominant or bulk wool over most of the body, (3) the belly wool, and (4) the head wool.

In the wool sorting operations, individual fleeces are separated out on the basis of such differences between body areas.

PRODUCTION AND HANDLING OF THE WOOL CLIP

By giving proper care and attention to the production and handling of the wool clip, the producer can contribute immeasurably to the quality of the product. Each of the most important factors from the standpoint of the producer will be treated briefly.

Proper Nourishment and Thrift

Skillful feeding and good management are important for the production of heavy fleeces with strong fibers. Periods of undernourishment, caused by poor feeding or the presence of diseases or parasites, result in a weak spot in the fiber. In the trade, this defect is called "tender wool." Wool buyers look carefully for this defect when buying wool; for if it is present, the wool cannot be used to make worsted yarn because it would break in processing. Tender wool is rejected and discounted in price by the buyer. It is manufactured on the woolen system where strength is not so important.

Free From Trash and Burs

The wool should be kept as free from straw, chaff, and burs as possible. Wool that is defective in this respect is discounted heavily in price by the wool buyer. Such impurities are difficult to remove mechanically in the textile mills, and often it is necessary to remove them by a chemical process called carbonizing

process cost five to ten cents a pound, an extra cost which ssed back to the wool grower. Suitable hay racks are easily e and are most helpful in keeping straw and chaff out of the . Also, the caretaker should be discouraged from carrying or straw over the backs of sheep.

If at all possible, burs should be prevented from getting into fleece by keeping the sheep out of such weed-infested fields. ew hard burs can be removed satisfactorily in the mill by nanical means, but the presence of many burs is objectionable a cause for discounting the price. The cocklebur and burdock, of the worst burs, are found in most parts of the United es. Spiral bur and spear grass are also very objectionable. l graders are trained to put one hand into the center of each e to feel for trash and burs.

er Use Insoluble Paint Brands

The indiscrimnate use of insoluble paint on sheep should be ded, for it will lower the value of the wool by as much as e cents per pound. Ordinary lead-base or tar paints will not e out in the normal wool-scouring operation. For this reason, wool sorter (who is among the highest paid of textile work- must separate out and clip off these brands with hand rs. Small particles of paint that escape the sorter go through the cloth and cause defects.

Despite these facts, practical sheep operators often find it ssary to brand sheep for one or more of the following rea- : (1) identification of western sheep on ranges, especially ic lands, where the bands of different owners may get mixed, identification with a "buck brand" at breeding time, and (3) tification of ewes and lambs at lambing time. The solution he problem, therefore, lies in using a brand which will sfactorily (1) serve for identification purposes, and (2) scour

In Australia, beginning in 1950, an improved sheep brand- fluid was developed experimentally and produced commer- y. It is claimed that this material has the desirable features of remaining on the sheep for a year, and (2) of being re- ed from the wool by normal scouring methods. In this coun- U. S. Dept. of Agriculture workers have developed a scour- branding fluid, but, to date, it has not been adequately tested. n so, similar branding fluids are now being marketed mercially.

It is likely that satisfactory scourable branding fluids will more than ordinary branding fluids. It is noteworthy, how-

ever, that the manufacturing cost of removing insoluble brands is about three cents per pound of wool. Although it should not be expected that all of this saving will be passed back to the wool producer, this is indicative that the trade is in a position to pay a premium for wool upon which scourable branding fluids have been used.



Fig. 256. Hand shearing. This method of shearing is fast becoming a lost art. (Courtesy, the Wool Bureau, Inc.)

Shearing

Shearing is the harvesting of one of the most valuable products, on a per pound basis, produced on American farms and ranches. It is the act of removing the natural clothing of sheep using either the machine or hand method.

The first mechanical sheep shearing equipment, called "the wheel of knives," was patented by S. G. Dorr of Albany, New York, on October 20, 1792. Through the years, subsequent im-

ements and refinements have been added, with the result the vast majority of the sheep of this country are now n by the machine method rather than by hand shears. The ern machine-shearing equipment—which may be powered by engine, electric motor, or hand—operates exactly like the ers of a barber. Machine clippers do a faster job, and the nals look smoother than when hand shorn. Yet some practical pmen prefer using the hand-shearing method, claiming that experience less blistering and losses from exposure follow- the removal of the fleece.



Fig. 257. Machine shearing. The modern machine shearing equipment ates exactly like the clippers of a barber. The vast majority of the sheep his country are now shorn by this method. (Courtesy, Sunbeam Cor- tion.)

IE OF SHEARING:

Shearing is largely a seasonal job. In southwestern United tes, many sheep are shorn in March, whereas in the North Northwest shearing may be delayed until about the first of . Most farm flocks in the Corn Belt states are shorn along ut corn planting time, early in May. In general, weather is the t important single factor in determining when shearing shall done. Unless shelter is available, the fleece should not be oved until the danger of cold rains and snows is past. With

the coming of warm weather, the yolk becomes soft, and the shears work better without "gumming up."

In addition to weather conditions, other factors which may be and are considered in determining the time to shear are:

1. **Availability of labor.**—This means professional shearers in the range area and over much of the rest of the United States or nonprofessional shearers for many small farm flocks. The latter generally consist of men who shear when the work does not interfere with more important or remunerative assignments.

2. **Time of lambing.**—Some prefer to shear before lambing, whereas others are insistent on delaying shearing until after lambing. Shearing before lambing requires careful handling of the pregnant ewe, but the lambs generally do better.

3. **Seasonal grazing conditions.**—In many range areas, especially in the North and Northwest, shearing is done before the sheep leave the spring range to migrate to summer mountain ranges. Usually, this permits shearing at or near headquarters or a shipping point and reduces handling and transportation charges on the wool clip.

4. **Weight of fleece.**—Early shearing results in lighter fleeces with lower grease content; but where wool is bought on an evaluation based on clean-wool yield, there is little object in delaying shearing merely to get a heavier fleece, for much of the increased weight is due to added grease content. Moreover, some individuals rub off or otherwise lose part of the fleece if shearing is very late.

5. **Flies.**—In certain sections, there may be great annoyance from wool maggot and screwworm flies if shearing is delayed until very late.

KEEP WOOL DRY:

Sheep should be shorn only when the wool is perfectly dry. Wool that is shorn and packed when wet mildews and spoils. Such wool cakes up into hard lumps which are easily spotted by the buyer. After bagging the wool, it should be stored in a dry place. Wool warehouses are the most satisfactory storage places.

REMOVE "TAGS":

All "tags" or lumps of manure should be removed before starting to shear. Soft tags will stain or discolor wool if allowed to remain on the fleece. A wool buyer discounts the price of the wool sufficiently for tags when present, so that he is on the

side. The good sheepman will keep the tags removed from to time, so that none will be present at shearing time.

AR IN A CLEAN PLACE:

The shearing should be done on a clean, dry surface. A can- carpet, or solid floor may be used to advantage. Above all, l shearing on dirty ground or soil, as it discolors the wool. y large range operators have special shearing sheds. What- the arrangement, one should be sure the ground or floor vept clean from straw, chaff, or dirt.

NDLE SHEEP CAREFULLY:

Good shearing, by either the hand or machine method, ires (1) that the sheep be handled carefully and without ry, (2) that the fleece be cut off smoothly and close to the , without second cuts, and (3) that the fleece be kept intact, er than torn apart. Although some minor modifications may , the usual steps and techniques used in the present method achine shearing were first developed by skillful shearers of tralia and introduced in this country in 1908. The best in- ction in this technique may be obtained by either studying ecially prepared motion picture of the subject or by attending earing school. To master these techniques, it is recommended the amateur work as an apprentice under the supervision n expert.

OID SECOND CUTS:

One should avoid second cuts in shearing. This means that shearer should not go over the same surface a second time. lo so results in fibers being cut twice, and their value is re- d. These short fibers are objectionable in worsted manufac- ng because they go into the "noil." Shear close to the skin make only one cut.

EP FLEECE UNBROKEN:

If the shearer is careful, he can keep the fleece in one piece. s will make a better looking bundle and will create a better ression with the wool buyer than a fleece that is broken and . It is much easier to grade and sort unbroken fleeces, because operator finds the various qualities in their correct position he fleece.

OID SKIN BITS:

Occasionally a shearer gets too close to the skin of the sheep nicks out a piece of skin and flesh. This should be avoided

as much as possible. Skin bits have to be removed in the sorting operations or they cause trouble in the textile machines.

ROLL THE FLEECE PROPERLY:

Many sheepmen do not realize the importance of rolling and tying a fleece in the proper way. A well rolled and tied fleece creates a good impression with a buyer. There is only one correct way to roll and tie a fleece. Put the fleece flesh side (cut side) down on the floor. Fold in each of the sides to meet at the center. Fold in the neck about as far as the shoulder. Start at the britch end and roll toward the neck. In this manner, the finest and best wool on the entire fleece will be on the outside of the bundle when it is finished.

USE PAPER TWINE TO TIE FLEECE:

Each fleece should be tied with a paper twine made especially for this purpose. The use of any type of cotton, jute, sisal, or other twine is not recommended because of the danger of small pieces going through the manufacturing operations along with the wool. Bits of paper twine that are not seen and removed in the sorting operation usually disintegrate and fall out in the



Fig. 258. A properly rolled and tied fleece. Note that only one string of paper twine has been used. (Courtesy, U.S.D.A.)

ring or carding operations. Any vegetable fibers in a piece vine that are not seen and go through into the cloth will show plainly after the dyeing process for they are not affected by dyestuff applied to the wool. A small piece of twine will be ed up in the carding machine, and when it arrives in the ic, it will damage many yards. Girls with tweezers are em- ed to pull out these defects in the fabric, or at times it is ssary to carbonize the cloth to remove them. Both methods costly, and neither is entirely satisfactory. Some mills now se to buy any wool tied with sisal twine. Tie the fleece by ing one wrap of paper twine around it, then turn it at right les and make another wrap around it. Now tie the two ends he twine, and the job is completed. The use of any twine but er will result in a lower price for the wool.

E REGULATION WOOL BAGS:

Much farm wool comes to market in small grain and feed s. It is difficult to get the wool out of these bags, and their is not recommended. One should always use a regulation l bag. It is made from jute and is 40 inches wide by 7½ feet



Fig. 259. Packing wool in a regulation wool bag immediately after aring, on a ranch in Oregon. (Courtesy, The Wool Bureau, Inc. Photo n Library of Congress.)

long, with a weight of about 4 pounds, though a shorter bag is often used in Texas and the Southwest. If a secondhand bag is used, see that it is turned inside out and shaken well before it is packed with wool. The machine lock-stitch seams should be on the outside of the bag when it is packed. Wool bags are opened down the side by the workers—by pulling out the lock-stitch—in the same manner that a sugar bag is opened at home. If the bag is packed inside out, it is impossible to do this.

PACK EACH KIND OF WOOL SEPARATELY:

When there is enough wool to warrant it, each kind or type should be packed separately. The operator should make at least a rough grading—putting fine wool in one bag, medium wool in another, and coarse wool in a third bag. In addition, a separate



Fig. 260. Rejections—fleeces that are black, dead, gray, cotty, etc.—should be packed separately. (Courtesy, U.S.D.A., Production and Marketing Administration.)

bag or bags should be reserved for such rejections as black, dead, gray, or cotty fleeces. If the rejections do not warrant a separate bag, they may be placed on top of the good wool, but should be separated out by means of heavy paper. With the farm flock, each kind of wool may be sorted as shearing progresses, but the range operator can best make this sort in the cutting chute before shearing. The owner should carefully look over all rejections, so that when the flock is culled, some of the sheep that are producing wool that is discounted heavily when sold can be culled out.

QUISITES OF WOOL

Good wool possesses character, purity, strength of fiber, l condition, cleanliness, low shrinkage, adequate but not ex- ive grease, uniformity, and a bright white color. These requi- s apply to all wools, regardless of the class or grade.

racter of Wool

Character in wool is that inherent characteristic that makes fleece stand out as being superior to another of the same s and grade. Character is judged largely by the crimp, which ıe waviness in wool, although other factors may be consid- l. Fine wool of good character may have twenty-five to thirty ıps per inch, while a similar wool, lacking in character, would e only about fifteen or less crimps per inch. Coarse wool may have five or less crimps per inch——even if it is of good racter—whereas poor wool of this type would be practically ight. Color, feel, and general make-up of the fleece also enter character of wool. Fleeces lacking in character are usually -out or frowsy in appearance.

ity of Wool

Purity in wool is a very important factor. A fleece is pure if ontains only true white fibers. Some breeds of sheep produce k or gray fibers, especially around the neck or the shins. It mpossible mechanically to separate the black fibers from the te fibers in manufacturing; hence wool of this type cannot be l for white fabrics. Wool containing even a few black fibers ejected from white lots, and it must be dyed a dark color.

Kemp is another type of fiber that affects the purity of wool. a malformed fiber, chalk white in color and very brittle. It is wasteful in manufacturing and shows up as a defect in the ric because it does not take dyestuff. Wool with kemp must removed in the sorting operation. Some wools are off-color in t they have a yellowish cast. They likewise are undesirable, ause they do not scour out white and cannot be used for white ns or fabrics.

ength of Fiber

Strength of wool varies greatly from fine wool to coarse l. Good wool has approximately the same strength through- its length. Defective wool in this respect has one or more k places along its length. If the weak spot is pronounced, the r will not stand the strain of manufacturing on the worsted

system. Wool of the latter type is not worth as much and can only be used to make woolens. Some of the common causes of weak or tender wool are: sickness of the sheep, radical change in feed, nutritional deficiencies, or general upsetting of the sheep.

Condition

Condition, when used in connection with grease wool, refers to the amount of grease, sand, dirt, and other solubles, present in the wool. A wool that has a high shrinkage is said to be "heavily conditioned." Wool is bought on the basis of how much clean wool it actually contains. Hence the amount, or percentage of condition, is an important factor when determining the grease-wool value.

Cleanliness

Grease wool is valued according to the amount of pure wool fiber it contains. Everything else that is present in grease wool must be removed in manufacturing. Sand, dirt, loam, grease, burs, chaff, grass, and seeds must all be removed. Some impurities—such as sand, dirt, and some vegetable matter—may be removed by dusting. Bur-picking removes burs. Other impurities—including suint, grease, dirt, etc.—may be removed by wool scouring. Still other impurities, as certain types of vegetable matter, may require further mechanical or chemical treatment. Grease wool requiring a minimum of effort to remove impurities brings the highest price when offered for sale. Most farmers and ranchers can do much to lessen the amount of straw, chaff, grain, and other vegetable matter found in wool. Some farmers pile their wool in the barn and allow it to collect dirt and dust for many months before it is sold. Wool that is bagged at shearing time is automatically kept clean until it arrives at the market.

Shrinkage

Shrinkage is the weight of impurities lost in the wool scouring. The result is usually expressed as a percentage of the grease weight. An example of fleece shrinkage is as follows:

10 pounds grease wool before scouring
4.5 pounds clean wool after scouring
5.5 pounds loss in wool scouring
5.5 pounds = 55 per cent = shrinkage
4.5 pounds = 45 per cent = yield.

It can be seen that yield and shrinkage percentages when added together give 100 per cent. The above example represents a fair average of all wools grown in the United States. Thus the aver-

ten-pound fleece loses 55 per cent of its weight in scouring, hat a ten-pound fleece of "greasy wool" yields about 4.5 nds of "clean wool." It is customary to base all clean-cost ulations on shrinkage. The ability to examine grease wool, estimate its shrinkage accurately is one of the things a wool er must possess to a high degree. No two fleeces of wool are tly alike. Many factors affect shrinkage, including breed, ate, soil, feed, etc. Shrinkage consists of: (1) the natural urities, yolk and suint; (2) acquired impurities, such as tags, l, dirt, etc.; and (3) added impurities, such as paints and nds. Wool buyers usually estimate the amount of vegetable ter in wool and include this factor when evaluating it.

Much controversy has always existed over shrinkage esti-es. Without doubt, many buyers, in estimating shrinkage, e deliberately erred in their own favor; but carefully conduct-scouring tests have conclusively demonstrated that even the alled experts cannot accurately estimate shrinkage or clean d. Because of this difficulty and the economic importance of urate evaluations, numerous gadgets and methods for arriv-at shrinkage or yield have been studied experimentally. At present time, the core method—in which a lot of wool is pled by means of a hollow tube and scouring determinations made on this representative sample—seems to be the most llible mechanical method for determining shrinkage or yield. ugh some individuals and firms of the wool and textile indus-violently oppose this method—objecting to such matters as noils resulting therefrom—it appears to be the best answer late for the large operators of the West.

or Grease in the Fleece

Wool is bathed with a greasy substance during the growth he fiber. This natural grease protects the fibers during growth prevents adjacent fibers from becoming cotted or felted on sheep's back. Wool grease in its natural or crude form is ed "degras," which is really a wax. It is refined and marketed a salve and is sold under the name of "lanolin." Wool grease is soluble in warm or cold water. It is generally removed from l by emulsifying it with soap, water, and alkali. In some tances, it is removed from wool by naphtha, in which it is uble. A normal amount of wool grease, evenly distributed oughout the length of the fiber, is an asset. Too much wool ase, as is the case in some heavy-conditioned buck fleeces is

undesirable because of the high shrinkage. In addition to the grease, wool also possesses suint. The grease, suint, and other impurities are commonly referred to as the yolk.

Evenness of Fiber and Uniformity

At the present time, many top-makers and mills measure wool-top fibers under a microscope magnifying five hundred times in order to establish the grade very accurately. This means that it is desirable to have wool as even and regular as possible. The grade of a fleece is a relative or comparative term, because it is understood that wool of many kinds or grades is found on one sheep.

The finest wool is found on the head and shoulders, and the coarsest wool is found on the britch. Even so, a fleece that is more even and regular than another and has fewer grades is the better one. Wool sorting separates an individual fleece into its various qualities. An even fleece is easier and quicker to sort than an uneven fleece. Uniformity is the result of good breeding and good management.

Color

Color is an important consideration in evaluating wool for manufacturing purposes. The whiter the wool, the greater is its value. Very little, if any, farm wool is true white in color. It usually has a yellowish tinge. The presence of pronounced yellow wool (canary-stained) is objectionable because the color does not come out in the scouring. Hence wool of this type cannot be used for white yarn.

Black wool is in reality from dark brown to light gray in color. The very dark fleeces are easily distinguished, but it is difficult, except for a trained man, to spot a fleece that has only a few black fibers mixed intimately among the white fibers. A fleece of the latter type is discounted and sells at the same price as black wool, with which it is manufactured. Some fleeces have patches of black or gray at the neck or around the edges of the shins. It is advisable for the owner to examine his sheep carefully for this defect and to consider it when he is culling out his flock.

Urine or manure-stained wool is another type of off-colored wool. Wool with this defect is usually separated out by the sorter. However, it is difficult to see all the stained pieces in grease wool, and, as a result, many mills also look over the scoured wools to remove any bits of stained wool that were overlooked by the sorter.

ASSES OF WOOL

In central livestock market vernacular, the market "class" ers to the use to which animals are put. In a broad way, the r classes of wool that are based largely on length of fiber also er to the use to which wool is put. Strictly speaking, however, s is in error; for factors other than length—such as supply demand, purity, condition, diameter, etc.—are important in ermining the use made of wools. Thus many wools used by woolen industry are longer than some used in worsted manuture; and a considerable amount of wool classed as clothing sed in the worsted industry. In general, however, the manuturer can realize the greatest profit by utilizing wools accordto their best adaptation as indicated by four classes: (1) bing wool, (2) clothing wool, (3) French combing wool, and carpet wool.

The trade recognizes two major classes of wool—"apparel ol" and "carpet wool." As the names imply, most apparel ols are those suitable for manufacture into yarns and fabrics apparel purposes, whereas most wools of the carpet class are d in making floor covering. Thus, combing, clothing, and nch-combing wools are often collectively referred to as parel wools.

mbing Wool

Combing wool is usually referred to as the highest priced best wool obtained from sheep. It is two inches or more in gth, with the length varying according to grade as shown in ble 47. By and large, combing wools are used for making rsted fabrics. They take their name from the fact that one of main operations in worsted manufacturing is the combing ration, which separates the long fibers from the short ones. e long fibers only are used in worsted, and the short fibers are d in woolen manufacturing. In the former, the fibers are laid rallel to each other; whereas in the latter, the shorter clothing ols that are used in making woolens and felts are laid in every ection—in fact, the more mixing, the better in woolens. These erences are of importance to the consumer. Among other ngs, they explain why "worsted suits" hold their press better n "woolen suits." Prior to World War II, approximately 70 cent of the apparel wool used in the United States was prosed on the worsted system of manufacture.

Clothing Wool

Clothing wool is a name usually given to the shortest wool. This wool is too short to be manufactured on the worsted system, but it can be used successfully on the woolen system. Although longer fibers can be used in making woolens, they are usually more expensive than short fibers and hence are reserved for making worsteds which usually sell at a slightly higher price than woolens. The term "clothing wool," however, does not mean that the wool is suitable only for fabrics to be made into clothing. This type wool is used for felts, hats, and fabrics of all types and kinds.

French Combing Wool

French combing wools are in between the combing wools and the clothing wools in length. These wools are manufactured on the French system of worsted manufacture which is designed to use shorter wool and still produce a worsted fabric. Thus the French system utilizes much wool that is not long enough for manufacture on the regular worsted system.

Carpet Wool

Carpet wool is of variable length, but of distinctly low quality. The chief requisites of carpet wool are coarseness and resilience, qualities that make them resistant to matting down and to wear under the constant scuffing of passing feet. Most of this wool comes from long-wool sheep that show lack of breeding. It includes most any wool that will not fit into the above three classes. Most U. S. carpet wools are imported because our flocks, except the sheep kept by Navajo Indians, have been improved to the point where the vast majority of wool grades as apparel wool. Carpet wools come chiefly from Russia, India, China, and South America.

WOOL GRADING

Wool grading is based primarily on fiber diameter or fineness, but consideration is also given to length. Many manufacturers desire wool of certain finenesses only. This means that the wool must be separated at the warehouse and like fleeces must be piled by themselves. This process is called wool grading, and it is done by a highly trained wool man. As the best of daylight is needed for grading, it is better done on the north side of the building. It is carried out as follows: a grading board is set up near a door or window, and several baskets or boxes are placed in convenient positions about it. The bag of wool to be graded

ought up to one end of the board, and it is opened up along eam by the grader's helper. The fleeces are thrown upon the and are examined, one at a time, by the grader. He looks e fleece as a whole and does not untie the twine. He consid- he diameter, length, strength, color, and other factors and quickly decides that the fleece is "½ Blood combing wool" hatever it may be. He then throws the fleece into a special et reserved for this particular fineness and length. As the ets are filled, they are trucked away, and the wool therein ilt into large piles on the floor. When a wool manufacturer



Fig. 261. Wool grading. Wool grading consists in the grader examining ntied fleece, and, on the basis of its dominant fineness and length, ng it in a pile of comparable characteristics. (Courtesy, U.S.D.A., uction and Marketing Administration.)

res wool, he can select it from the many large piles, each of which contains fleeces of a different quality. Grading does infer that the wool in a pile is all of one diameter. Any single e of wool as it comes from the sheep possesses many differ- qualities of wool. Thus a "½ Blood combing wool" simply ns that the greater part of the wool on the fleece is of that ness and length. The manufacturer knows that some wool hese fleeces, especially on the shoulder part of the fleece, will iner and also that some wool, as on the britch, will be consid- ly coarser. Because of this, a further separation, known as ing, follows. The ability to grade wool, which is acquired only n considerable experience, requires a keen sense of sight com- d with the sense of touch and rare good judgment.

Grades of Wool

There are many factors which enter into the value of grease wool, but among the most important are diameter and length. The diameter of fiber or relative fineness determines the grade. Wool can be separated roughly, after a little experience, into three broad grades according to its diameter: (1) fine wool, (2) medium wool, and (3) coarse or braid wool. More accurately speaking, however, there are two distinct methods of grading wool according to diameter with several grades in each. The older method is called the "blood system"; the newer method is called the "wool-quality-number system." A comparison of these two systems is contained in Table 47:

TABLE 47
COMPARATIVE WOOL CHART[1]

Type of wool	GRADES		Approximate diameter (inches)	CLASSES			
	Wool quality number	Blood grade		Combing wool length (inches)	French combing wool-length (inches)	Clothing wool length (inches)	Maximum worsted spinning counts
				over		under	
Very fine	80s	Fine	.00077	2	1¼ to 2	1¼	80s
Very fine	70	Fine	.00083	2	1¼ to 2	1¼	70
Fine	64	Fine	.00087	2	1¼ to 2	1¼	60
Medium	60	½ Blood	.00093	2¼	1¼ to 2¼	1¼	50
Medium	58	½ Blood	.00098	2¼	1¼ to 2¼	1¼	46
Medium	56	⅜ Blood	.00106	2½	1½ to 2½	1½	38
Medium	50	¼ Blood	.00120	2¾	1½ to 2¾	1½	34
Coarse	48	¼ Blood	.00130	2¾	1½ to 2¾	1½	30
Coarse	46	¼ Blood	.00138	3	2 to 3	2	28
Coarse	44	Common	.00144				26
Very Coarse	40	Braid	.00152				22
Very Coarse	36	Braid	.00157				18

[1] Note: Common and Braid are not classified according to length because these wools are practically always of combing length. Carpet wool includes all those not suited to the three classes listed.

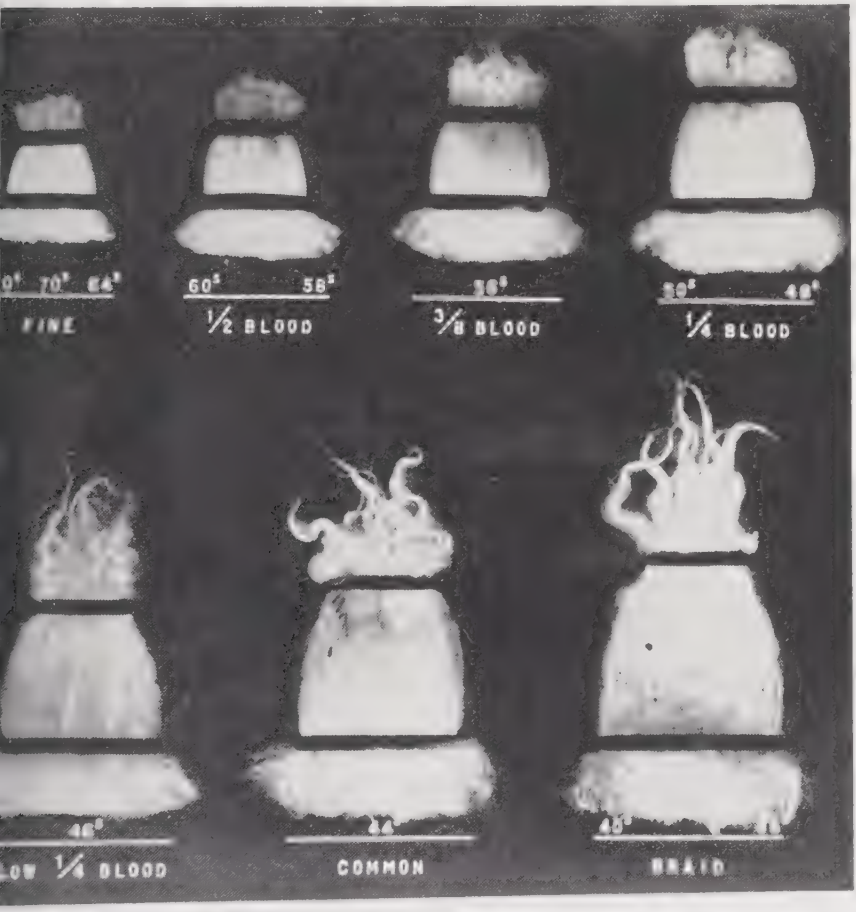
An experienced wool man determines the grade of wool by the senses of sight and touch; whereas the research worker may use calipers or photomicrographic equipment.

The bulk of wools produced in this country is distributed by grades as follows:

Blood Grade	Wool Quality Number	Per Cent of Total U. S. Production
Fine	64's and finer	54.5
½ Blood	58's-60's	13.4
⅜ Blood	56's	15.4
¼ Blood	48's-50's	10.3
Low ¼ Blood	46's and coarser	0.9
Common and Braid	36's-44's	0.2
Off Wools		5.3

BLOOD SYSTEM:

The blood system divides all wool, from finest to coarsest, even grades. These are: (1) Fine, (2) $^1_2$ Blood, (3) $^3_8$ Blood, $^1_4$ Blood, (5) Low $^1_4$ Blood, (6) Common, and (7) Braid. nally these fractional "Blood" names denoted the amount of no blood in the sheep producing the wool. At the present these names indicate wool of a certain diameter only and no connection whatsoever with the amount of Merino blood e sheep. As a matter of fact, it is possible to have "$^3_8$s Blood " from a sheep with no Merino blood at all. The blood grades, efore, are merely trade names identifying the different es of wool, without relationship to the breeding of the sheep.



ig. 262. Grades of wool. The grade is determined primarily by diam- f fiber. Note the relationship of the numerical terms or wool quality er to the "blood" grade. (Courtesy, U.S.D.A., Production and Mar- g Administration.)

WOOL QUALITY NUMBER SYSTEM:

The wool-quality-number system divides all wool into twelve grades, and each grade is designated by a number. The numbers range from eighty for the finest of wool down to thirty-six for the coarsest. This method gives more grades, and thus finer divisions can be made; and this is more satisfactory to the wool dealers and manufacturers. The preceding table shows the correlation between the two grade systems.

WORSTED SPINNING COUNT

Theoretically, the wool-quality-number system is based on the number of hanks of yarn (each hank representing 560 yards) that can be spun from one pound of such wool in the form of top. Wool of 50's quality, therefore, should spin 50x560 yards per pound of top, if spun to the maximum on the worsted system of manufacture. Unfortunately, this is not always true; the lower grades will not spin up to their number. Moreover, it is noteworthy that, in actual practice, wools are rarely spun to their maximum limit. Furthermore, spinning count is not determined by diameter alone; such factors as fiber length, moisture conditions, and the skill of the workmen influence the count that may be spun. It may be concluded, therefore, that neither the blood system nor the wool-quality-number system denote accurately what they are supposed to indicate according to derivation.

WOOL SORTING

Sorting is the operation of taking an individual fleece, untying the twine, opening the fleece, and separating the fleece into the various grades that it possesses in the different body areas. This operation is usually done in the mill, but occasionally it is done in a warehouse. The reason for this is that a mill knows exactly what qualities of wool it wishes to put into a fabric. The object of sorting is to obtain large lots of wool that are very even and uniform in diameter, length, strength, and other characteristics. It is easy for an inexperienced person to distinguish a very fine wool from a very coarse wool, but it takes considerable training to be able to separate two consecutive grades, such as 56s, from 58s. Sorting is always done on the grease wool. The dusting and scouring operations break up the fleece into small pieces, so that sorting of scoured wool is impracticable. Sorting is necessary on wool if a uniform worsted yarn with high spinning count is desired. If the wool is not to be spun to the maximum count, then only a superficial sorting is necessary. The

ughness of the sorting varies according to the type of fabric ool is to be made into.

MARKETING OF WOOL

Like most industries, the wool and textile business has pro-ed from the status of a family enterprise. In the early days is country—and the same pattern held true in other nations tually every family owned a few sheep and produced suffi- wool to meet its own needs. Under the family system, card-



ig. 263. Display of wool for prospective wool buyers. (Courtesy, .A., Production and Marketing Administration.)

spinning, and weaving were carried on by members of the ehold for the purpose of supplying the family with clothing. er these conditions, there was little or no marketing. With oncentration of population in the cities, the coming of arti- and craftsmen, and the bringing of wool from more distant ts, however, markets were a necessity.

Today, wool is one of the most important commodities of d commerce, and it might well be added that the marketing ations connected therewith are among the most intricate. e first place, it is one of the most difficult items of commerce assify and grade for the benefit of the trade. Secondly, few s have to be transported greater distances from producers onsumers. Wool production is a frontier type of industry, the surplus-producing areas in those regions that are rela-

tively undeveloped. On the other hand, wool consumption is greatest in the more populated regions.

International Trade in Wool

Nearly two-thirds of the world's wool production is in the Southern Hemisphere, with the leading export countries consisting of Australia, Argentina, New Zealand, British South Africa, and Uruguay. On the other hand, the great wool-consuming nations are in the Northern Hemisphere, and, prior to World War II, included the United Kingdom, France, Germany, United States, Belgium, and Japan.

The United Kingdom has long been the largest wool-handling country, with London the greatest wool market in the world. The wool auction sales in London serve as the barometer of the world for wool used in the manufacture of clothing, whereas similar sales in Liverpool set the world price on carpet wools.

Boston is the leading wool market of the United States and ranks second only to London as a world market. About three-fourths of each of our domestic and foreign wools are handled in Boston, largely on Summer Street. Philadelphia, Chicago, and New York are also important wool marketing cities, the first two for domestic wools and the latter for foreign wools and wool substitutes.

In order to protect American sheep producers, there is an import duty of 25.5 cents per pound "clean content" on apparel wool of the type generally grown in this country (wools finer than 44s). Wools of the type not grown in this country are imported free of duty when used for floor coverings, press cloths, knit or felt boots, or heavy fulled lumbermen's socks.

Methods of Marketing Wool in the United States

There are several differences between the marketing of animals on foot and the marketing of wool. In the first place, the average stockman is usually familiar with more than one of the several avenues through which live animals may be disposed, whereas, except for the larger wool growers, there is generally little knowledge concerning possible market outlets for wool. Also, practically all of the vast quantity of wool grown in the United States is bought and sold by private agreement, with no open- or auction-market arrangement to set values through competitive bidding. For this reason, it is difficult for the grower to know what his wool is worth. On the other hand, it must be recognized that an open market or auction would have its limita-

in being informative to the grower for the reason that es and grades of wool are so elusive and that it still is not tical to secure shrinkage determinations on small lots, even the modern core system.

Another peculiarity of wool marketing is its high degree of entration, for a very large proportion of the total clip passes ugh the two leading centers of Boston or Philadelphia.

It is possible for the grower to sell his wool through several cies—including both private enterprises and cooperative ciations—the chief ones of which are: (1) local buyers, (2) merchants, (3) commission houses, (4) brokers or mill ts, and (5) cooperative associations.

AL BUYERS:

Local or country buyers operate mainly in the farm flock s, buying small clips on a cash basis. Usually such buyers ly purchase wool as a seasonal sideline, having a year-around ness in such commodities as grain, livestock, produce, or junk. local buyer may purchase wool on his own account for specue purposes or buy on a predetermined commission basis for ol merchant. In general, most local buyers have little knowl- of wool quality and buy all clips at a flat rate for the entire nunity. Under this system of marketing, there is little incenfor producing a quality product.

OL MERCHANTS:

The wool merchants (also known as state dealers, centralket dealers, or wool-warehouse companies) handle most of wool grown in this country. They buy wool on a cash basis, er dealing with local buyers or directly with the producer. perform such important services as grading, warehousing, the assumption of risks incident to possessing large amounts ool. Wool merchants may sell to other wool merchants or tly to manufacturers. Theirs is a legitimate business, but profits are largely dependent upon being able to buy at the st possible price, with the chance of reselling at a sufficiently figure to cover their services and realize a profit.

MMISSION HOUSES:

Wool commission houses (also known as commission merts) perform services similar to those rendered by the comion companies on the central livestock markets. Essentially, are agents of the wool grower, operating on a percentage s for storing and selling his clip. Usually the grower is kept

informed of the price offered for wool, but his sanction is obtained before the wool is sold. In some instances, however, the grower may give the commission house full responsibility for the sale. Unlike livestock commission companies, some wool commission houses also buy wool. Sometimes the latter privilege has been the subject of bitter criticism, because often the opportunities for profit are larger through purchase and speculation than through merely handling on a commission basis.

BROKERS OR MILL AGENTS:

Brokers or mill agents buy for the manufacturer. Their purchases are made from any of the established marketing agencies or directly from the producer. They attempt to acquire the classes and grades that the mill can use, although usually the wool is sorted upon its arrival at the factory.

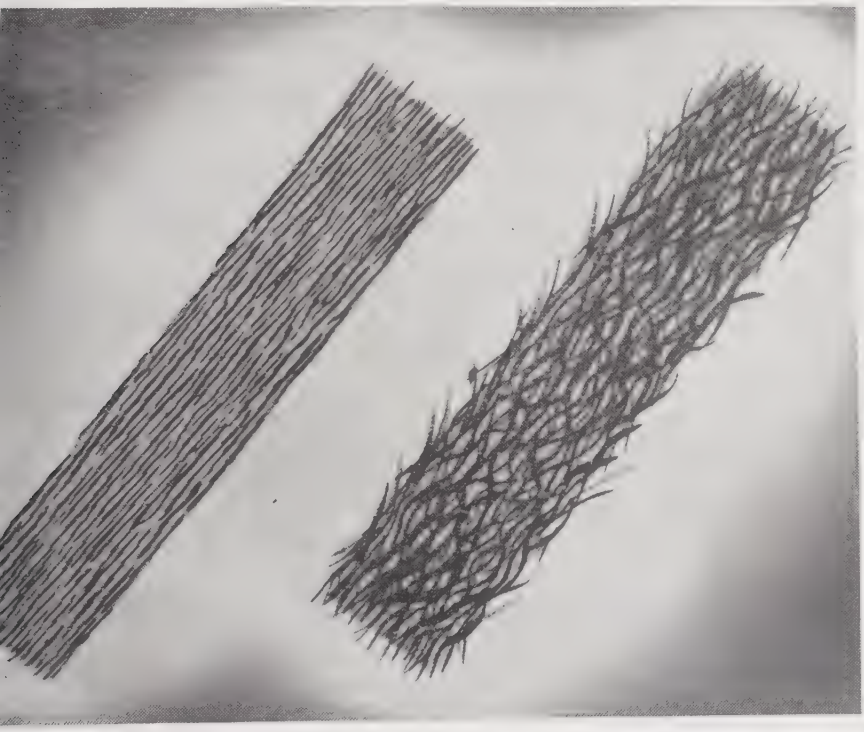
COOPERATIVE ASSOCIATIONS:

In recent years, the cooperative plan of selling wool has gained in favor. This movement in the wool trade had its inception in 1918, with the organization of the Ohio Wool Growers Cooperative Association. The first cooperative was so successful that it became a permanent institution, and numerous other similar organizations scattered throughout the country have since come into existence. At the present time, cooperative associations handle from 10 to 15 per cent of the domestic wool clip. These groups vary widely in the manner of organization and services rendered to their membership. In general, however, they assemble and pool the wool clip of their grower-members and grade and hold it for the inspection of wool buyers. Frequently, money is advanced to the grower on the wool that is so pooled, with final settlement being made after completion of the sale and deduction of handling charges. Most cooperatives have their members execute binding, signed contracts—some of which stipulate that the members must deliver their wools for sale by the agency for a period of years, whereas others carry a "retainer agreement" wherein the grower reserves the right to sell his clip elsewhere but with the understanding that he will pay a certain fee to the cooperative if he follows such a course. The largest cooperative association in the United States is the National Wool Marketing Corporation, which was founded in 1929 at Boston, Massachusetts. In general, cooperatives have rendered valuable service, many of them being especially helpful in the educational programs conducted among their members. Also this

od of marketing insures growers full market value for their
ıct, less actual marketing charges.

MANUFACTURING PROCESSES

After wool is purchased by the manufacturer, it must pass
ıgh a number of intricate processes before the final product
es. Wool fabrics are of two types—worsteds and woolens,
requiring different manufacturing and finishing processes.
ens are made from the shorter wool fibers—carded but not



ig. 264. Enlarged diagram of worsted (left) and woolen (right)
. The longer fibers are combed out parallel for worsteds, which ex-
why worsted suits hold their press better than woolen suits. (Cour-
The Wool Bureau, Inc.)

ed—with the result that the little fibers in the yarn are in
ss-cross position, giving a soft, fuzzy yarn, as in broadcloth.
weave of a woolen cloth is more or less concealed by the
finish. A woolen also is usually softer and less firm than a
ted. Common worsted fabrics include serge, gabardine, rep
coverts. Common woolen fabrics are cheviot, tweed, flannel,
dcloth, melton, kersey, cassimere, and mackinaw.

The longer fibers are used for worsteds, and they are combed
dition to being carded. The combing process places the fibers

parallel, giving a yarn that is spun more tightly than the woolen yarns, as in serge. A worsted also has a clear-cut weave and a smoother surface than a woolen.

The steps in manufacturing worsteds and woolens vary according to the available equipment, kind of wool, and the finished product desired, but in general they consist of the following: (1) sorting; (2) dusting and opening; (3) scouring; (4) drying; (5) carbonizing or bur picking; (6) blending, oiling, and mixing; (7) carding; (8) combing; (9) spinning; (10) weaving or knitting; and (11) dyeing and finishing.

Wool, From Fleece To Fabric

The steps in the manufacturing process, together with the quantities of products obtained at the different stages, are clearly presented in the following informative summaries prepared by the National Association of Wool Manufacturers, 386 Fourth Avenue, New York City:[1]

A. In the manufacturing of woolens, 6 pounds of grease wool (¾ of one fleece) furnish the following:

a. 4.4 pounds of scoured wool and noil.
b. 4.1 pounds of carded roping stock.
c. 4 pounds of spun woolen yarn.
d. 3 yards and 1 inch of gray goods, ready for dyeing.
e. 3 yards of finished fabric after sponging.
f. yardage to make one woman's woolen coat.

B. In the manufacture of worsteds, 8.68 pounds of grease wool (1-1/5 fleeces) furnish the following:

a. 4.34 pounds of scoured wool.
b. 4.17 pounds of carded "sliver" stock.
c. 3.62 pounds of worsted top, combed fibers; plus .55 pounds of noil, a by-product of the combing operation.
d. 3.44 pounds of roping stock ready for spinning.
e. 3.20 pounds of spun worsted yarn.
f. 3 yards and 27 inches of gray goods, ready for dyeing.
g. 3 yards and 18 inches of dyed goods, piece or yarn dyed; the fibers could have been stock dyed if desired. (This operation would follow scouring and precede carding.)
h. 3 yards and 13½ inches of finished fabric after sponging, which is enough for one man's worsted suit.

[1]Secured from *American Fabrics*, No. 7, 1948, p. 135.

Knowledge of these numerous operations furnishes an ex-
ation for the often considered elusive reasons why there is
nuch difference in the price of grease wool and a suit. To be
e specific, it is estimated that, out of each dollar which the
umer spends for clothing, the wool producer gets 11.4 cents;
l merchandisers, 2.7 cents; manufacturers, 50.1 cents; whole-
rs, 2 cents; and retailers, 33.8 cents.

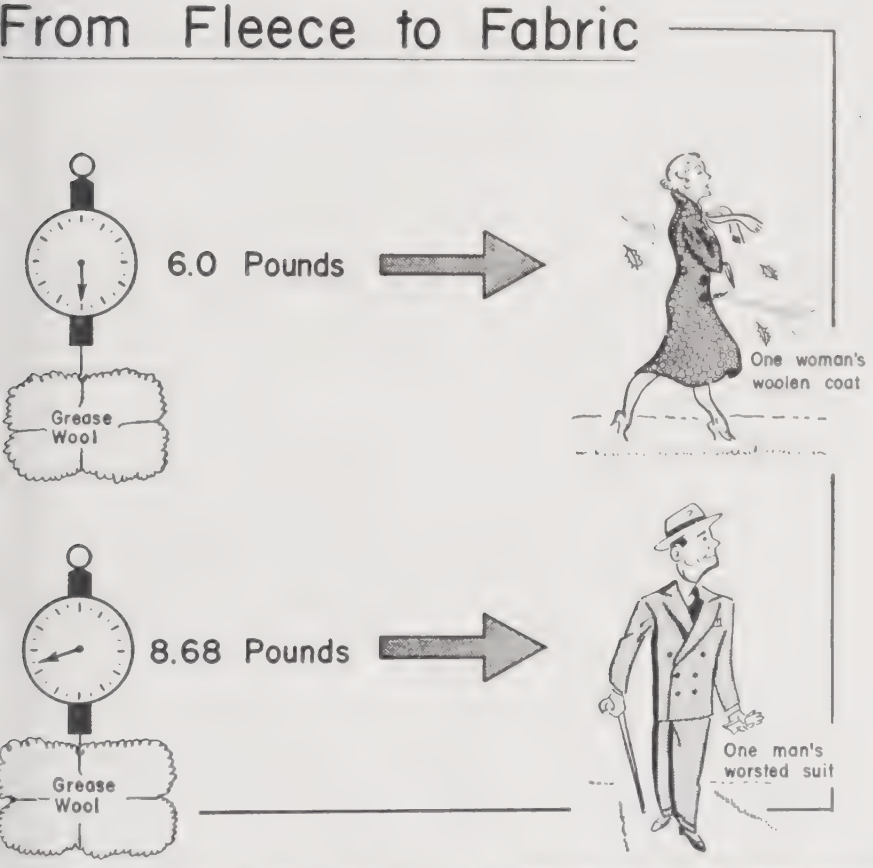


Fig. 265. Wool, from fleece to fabric. It requires 6 pounds of grease (¾ of an average fleece) to make one woman's woolen coat. It re-s 8.68 pounds of grease wool (1 1/5 fleeces) to make one man's worsted (Drawing by R. F. Johnson.)

HAIR

Mohair, known as the most versatile of fibers, is produced he Angora goat, one of the oldest animals known to man. few citizens in the United States are more than casually re of the Angora goat or its existence, despite the fact that e animals graze millions of acres of land and the hard-wear-abrics made from their lustrous coats are used and admired

from coast to coast. Mohair possesses qualities all its own, found in no other animal fiber. It has less crimp and smoother surface scales than sheep's wool. These qualities add luster, softness, and dust resistance to the other fine qualities mohair shares with wool. Mohair has remarkable resistance to wrinkles, great strength, and unequalled affinity to brilliant, deep colors that resist time, the elements, and hard wear.

World Mohair Production

At the present time, the goat is bred on a commercial basis for fiber production in three countries: the United States, Turkey, and the Union of South Africa. The goat population and mohair production of each of these nations for the period 1932-1938 is shown in Table 48.

TABLE 48

NUMBER OF GOATS AND MOHAIR PRODUCTION IN PRINCIPAL COUNTRIES[1]
(In Millions)

Average 1932-1938, 7 year period	UNITED STATES		TURKEY		UNION OF SOUTH AFRICA		TOTAL	
	Head	Pounds	Head	Pounds	Head	Pounds	Head	Pounds
Av. 1932-1938....	3.883	16.4	3.124	11.0	0.948	7.9	7.955	35.3
Per cent....	48.9	46.5	39.3	31.1	11.8	22.4	100.0	100.0

[1] *National Association of Wool Manufacturers Bulletin*, Vol. LXIX, 1939. Later figures not complete for Turkey and Union of South Africa. In 1949, the United States had 2,875,000 head of goats.

In 1949, the production of mohair in this country was 14,633,000 grease pounds, while the production in Turkey was approximately 10,500,000 pounds and in the Union of South Africa approximately 4,000,000 pounds. The United States has been the largest producer of Angora goats and of mohair for more than twenty years.

U. S. Mohair Production and Consumption

Though goats are rather widely distributed throughout the United States, the production of goats and mohair is of economic importance in a comparatively few states only. Table 49 summarizes important data relative to the mohair industry of the United States. As may be noted, Texas is by far the leading state in Angora goat numbers and mohair production. In fact, about 90 per cent of the commercial mohair of this country is produced in the Lone Star State. It is also noteworthy that, during the 10-

period from 1937 to 1946, the farmers and ranchers of the ed States produced an average annual mohair clip of 72,000 pounds, which brought in annual receipts aggregating 23,000. Thus mohair production is a sizeable industry.

In addition to being the largest producer of mohair, the ed States is the largest user of this fiber. In 1945, the goat ers of this country produced 22,038,000 pounds of mohair, an additional 10,569,000 pounds were imported. Since June 1948 the import duty on mohair in the grease has been 22 s per pound, and on scoured 25 cents.

air Characteristics

As may be noted in Table 49, Angora goats, on the average, r an annual clip of 4.8 pounds of unscoured fleece per animal. ebred herds often clip double this amount. Much of the do- tic mohair, especially that produced in the Southwest, is n off in two clips per year, in the spring and fall, whereas kish mohair is usually allowed a full year's growth prior to ring.

TABLE 49

BER OF GOATS CLIPPED, MOHAIR PRODUCTION, AVERAGE ICE PER POUND RECEIVED BY FARMERS AND RANCHERS ND CASH RECEIPTS, BY PRINCIPAL PRODUCING STATES, AVERAGE, 1937-1946, AND ANNUAL 1947[1]

tate 47 rank in clipped)	Goats clipped[2]		Av. clip goat		Mohair production		Price pound		Cash receipts	
	Average 1937-1946	1947	Average 1937-1946	1947	Average 1937-1946	1947	Average 1937-1946	1947	Average 1937-1946	1947
	1000	1000	lbs.	lbs.	1000 lbs.	1000 lbs.	Cents	Cents	$1000	$1000
------	3,541	3,445	4.9	5.1	17,250	17,407	54	54	9,324	9,422
ex. ----	184	72	5.0	5.1	910	368	48	53	430	195
na -----	189	72	4.0	3.2	761	232	48	52	362	121
uri ---	84	60	2.5	2.9	204	177	40	38	81	67
n -----	105	57	3.9	3.8	417	217	42	42	171	91
------	25	18	3.6	3.5	92	63	38	37	35	23
-------	26	4	5.2	3.0	138	12	41	37	55	4
------	4,154	3,729	4.8	5.0	19,772	18,476	52.6	53.7	9,923	7,526

4 *gricultural Statistics, 1949*, U. S. Dept. of Agri., 1949, p. 397.
In states where goats are clipped twice a year, the number clipped is um of goats and kids clipped in the spring and of kids clipped in the

The three types of fleeces, based on the type of lock and ed according to desirability are: the tight or spiral lock, the ock, and the fluffy fleece. The tight lock hangs from the body nglets and is associated with the finest fibers. The flat lock ually more wavy and coarser, but it is associated with heavy ring weight. The fluffy fleece is objectionable because it is

easily broken and is torn out by brush to a greater extent than the other types.

The length of fiber averages about twelve inches for a full year's growth and six inches when the animals are shorn semi-annually. Sometimes, with animals that do not have a tendency to shed and when special attention is given to tying the fleece up, mohair up to three feet long is produced in a period of three years. Such exceptionally long fibers are used in making ladies' switches, dolls' hair, and theatrical wigs.

In fineness, or diameter of fiber, mohair is somewhat coarser than wool. Length and luster are more sought than fineness. The fibers are usually very strong, high in luster, whitish in shade, fairly soft to the touch, and straight in staple appearance. Unfortunately, most mohair contains considerable kemp, which is highly undesirable from the standpoint of the manufacturer. Without doubt the amount of kemp can be lessened through breeding and selection.

Mohair shrinkage in scouring averages from 15 to 17 per cent and does not depend on fineness, as does wool, since adult mohair shrinks as much as does kid mohair.

Production, Handling, and Marketing of Mohair

Although mohair is usually accorded more neglect than wool, the principles involved in the economical production and advantageous marketing of a high quality product are the same with both fibers. For practical reasons, chiefly as a means of lessening fleece losses caused by shedding or brush, more goats are shorn twice per year than is the case with sheep. Also in the Southwest goats are shorn twice each year because of the warm weather. Except for this difference, and the fact that it is not recommended that the mohair fleece be tied at shearing time, the discussion already presented relative to the production, handling and marketing of wool is equally applicable to mohair. The market channels and leading market centers for wool and mohair are identical.

It is unfortunate that a large amount of the mohair produced in this country continues to be marketed by placing all grades in a single bag, with little attention given to sorting. On most shearing floors, altogether too little attention is given to keeping the fleece intact and rolling it together in order that an intelligent job of grading and sorting may be done later. So long as these careless production methods are followed, mohair will neither meet the highest requirements of the manufacturer nor command a top price for the grower.

At least 90 per cent of the mohair is handled by the Boston ket. It then may be sold to a mill in the original bag or on a ed basis, or it may be combed and sold in the form of tops.

ses and Grades of Mohair

Unfortunately, there appears to be far less standardization e classes and grades of mohair than exists for wool. Kid hair est and is especially sought by mills. The fleeces from adults pecially bucks and old wethers—is the coarsest; and that yearlings is intermediate between the other classes. These es can be recognized by the grower and should be packed rately at shearing time. In addition, those fleeces that are ex-ely coarse, weak, and shorter than 6 inches or those having xcess of kemp, burs, or other foreign matter should be kept rate from clean, strong fleeces of desirable length and fine-

In 1951, in an attempt to standardize the grades of mohair, J. S. Dept. of Agri. invited comments on the following pro-d classification:

Grades

Spring Shorn Mohair	Fall Shorn Mohair
49s	49s
36s	36s
32s	32s
28s	28s
24s	24s
20s	20s
16s	16s

It will be noted that these proposed grades have been set two series, one for spring shorn and the other for fall shorn air.

As with wool, the grades of mohair are based primarily on presumed spinning count obtainable on the Bradford system the number of 560-yard hanks to the pound). In practice, ess is associated with softness and is recognized by the rienced touch when handled between the thumb and fingers.

s of Mohair

Mohair is used for car upholstery, portieres, robes, rugs, ds, and artificial furs; and there is considerable use of su-or mohair in suit linings and for men's summer suitings. The -fibered mohair is also in demand for use in manufacturing s and switches for theatrical purposes.

CHAPTER XXV

GOATS[1]

Goats were probably among the first animals domesticated by man. Goatlike remains are found in the ruins of the Swiss lake dwellings of the New Stone Age; and, according to historical records, domestic goats and sheep were driven over the damp fields of the Nile Valley to trample the seed into the soil for the farmers of ancient Egypt. Also, according to Old Testament literature, goats were very versatile helpmates to man in Biblical days. They furnished milk for food, fiber for clothing, skin for bottles and were the object of many a sacrificial offering for Jehovah.

Although there are many breeds of goats in the Old World, only a few have been introduced into America. These are divided into two groups: (1) mohair-bearing goats, and (2) milk goats.

THE ANGORA GOAT

The vast majority of the goats in America belong to the mohair-bearing Angora breed. Although there are about four million head of these strange-looking, heavy-coated creatures in this country, few people outside the Angora goat districts know what they look like.

The breed derives its name from Angora, a province in Turkey, in which land the breed originated. Angora is a high plateau, lying from one thousand to four thousand feet above sea level. In 1881, the Sultan of Turkey passed an edict prohibiting the exportation of Angoras, expecting thereby to confine the mohair industry to Asia Minor and forever after hold a monopoly upon the mohair trade. Thirty years later, in 1910, South Africa followed suit, passing a law for the same purpose. Subsequent events have proved that both Turkey and South Africa were too late in their efforts to hold a monopoly on the mohair trade, for some of the choicest Angora blood had already been brought to the United States.

[1]Since Texas is the leading state in Angora goat numbers, the author especially appreciated the authoritative review accorded this chapter by Professor J. M. Jones, Chief, Division of Range Animal Husbandry, Agricultural and Mechanical College of Texas, College Station, Texas.

The Angora goat was first introduced into this country by James B. Davis, of Columbia, South Carolina. Doctor Davis been sent to Turkey by President Polk in answer to a request e by the Sultan for someone to experiment in the production otton in that country. Upon returning to the United States 849, thirty-two years before the Sultan's edict, Dr. Davis ught with him nine choice Angora goats, including seven does two bucks. These and subsequent importations founded in United States the Angora industry which continued to thrive his new land despite later restrictions imposed by Turkey.

tribution and Adaptation

Table 50 lists the seven leading goat states, by rank, and total number of goats in the United States.

TABLE 50

UMBER OF GOATS AND KIDS IN SEVEN LEADING GOAT-PRODUCING STATES, BY RANK, 1945[1]

State	Number, 1945
as	2,991,324
souri	150,576
v Mexico	146,295
ansas	95,195
zona	90,228
gon	76,443
ifornia	60,555
ted States Total	4,265,501

[1]United States Census of Agriculture, 1945. General Report, 400.

It is noteworthy that in 1945 Texas alone accounted for 1,324 of the United States total of 4,265,501 goats. The huge t population of Texas is due principally to the fact that the e Star State has a large area of rugged grazing land which is l adapted to utilization by this species. The center of goat ing in Texas is in the south central part of the State, a region erally known as the Edwards Plateau. The area is character- l by rolling hills, somewhat rough and broken, covered by sses, cedar and oak trees, and a considerable amount of brush. e elevation is between 1,500 and 3,000 feet, and the rainfall ies from 15 to 25 inches per year.

Generally speaking, the densest Angora goat populations in s country are found in those areas in which the grazing is too nty, rough, or brushy for cattle or sheep. On the other hand, ery large percentage of Texas Angora goats are handled on



Fig. 266. Typical Angora flock on a west Texas ranch. Texas is the leading Angora state of the nation. (Courtesy, Sheep and Goat Raiser.)

the same ranges that support cattle and sheep. The goats utilize browse which would be of little or no value to sheep and cattle and keep the brush from crowding out the natural grasses. On cut-over lands of the Pacific Coast states and in the Ozarks of the central states, Angora goats are frequently used for clearing land of brush; but if this end is to be accomplished, the area must be heavily stocked and closely grazed.

Characteristics

At the present time, the Angora goat of this country is considerably larger and more rugged than its Turkish ancestor. This transformation in type has been accomplished through long-continued selective breeding and some infusion of common or so-called Mexican goats. In range condition, mature bucks weigh from 125 to 175 pounds and does from 80 to 90 pounds. The breeders of this country prefer considerable size so long as it is not necessary to sacrifice fleece quality, because the added size gives a larger surface area upon which to produce a heavy fleece.

Angoras are almost always pure white, although a black one appears occasionally. Red kids will shed their hair and produce white mohair later, but it is recommended that these animals be culled out and sent to slaughter.

The outer coat of the animal is made up of long locks of strands of hair, known commercially as mohair, which cover

animal's body. The fleece should cover all parts of the body pt the face and should be characterized by fine quality, a curl, and high luster. It should be as free from kemp as ible.

Under range conditions, does and kids shear three and one- to four and one-half pounds and wethers four to five pounds ohair annually, which is usually removed in two clips. The fleeces possess ample quantities of natural oil, and the best ns of Angoras show no tendency to shed.



ig. 267. Angora buck with a two-year mohair fleece. Note the long of hair that touch the ground. (Courtesy, J. M. Jones, Texas A. & M. ge.)

The body conformation should be symmetrical and denote a constitution. Both sexes are usually horned, but polled indi- als occur. The rather thin, long, and pendulous ears droop of the hair.

stration

The first United States breed registry association for Angora s, known as the American Angora Goat Breeders' Associa- was established in 1900. From that time until 1924, all ani- registered by this association were either the original ected stock and their progeny or goats subsequently im- ed. A second registry, known as the National Angora Record

Association, was organized in 1918; but six years later, in 1924, it was merged with the American Angora Goat Breeders' Association. Today, the lineage of registered Angora goats in this country is recorded in the American Association only.

As in sheep production, the breeding of registered Angoras is considered a specialty business, and few large range goat operators engage therein. Yet, most practical commercial goat producers prefer to use registered bucks and patronize the purebred breeders in order to secure bucks of a type that they hope will improve their herds.

Management of Angora Goats

The proper care of goats differs little from that which should be accorded sheep under similar conditions. Like sheep, goats pay dividends for good management. It is unfortunate, therefore, that there is a widespread and common belief that goats will thrive despite neglect. This popular conception is not true. The successful goat raisers apply the same careful care and management to goat raising as is given to any other profitable livestock enterprise. Success with goats can be achieved in no other way. In the discussion which follows, particular attention is given to principles or systems of management wherein goats differ markedly from sheep. Needless repetition on such matters as fencing, castration, watering, etc., is omitted.

HERDING:

A large number of the Angora goats in the United States are maintained under range conditions, where they are grazed in herds much like range bands of sheep. These herds vary in numbers from a few hundred to over two thousand head, with an average herd numbering about one thousand two hundred. On rough range or in thick brush, a larger number than one thousand two hundred can seldom be properly controlled by a single herder.

The principles and practices of good herding with goats are almost identical to those with sheep. There is one distinct difference: Rarely do sheep herders work ahead of the band; whereas it is common practice for a goat herder to work in front, turning the lead goats back to avoid unnecessary travel.

At the present time, most of the goats of Texas and other southwestern states are "loose grazed" (unherded) in so-called wolf-proof fenced ranges, in the same manner that sheep are handled in this area.

EDING:

The normal breeding habits of goats and sheep are similar, the former having a slightly longer estrus period and a ation period one to two days longer (the gestation period of s varies from 147 to 155 days). The does are usually bred at their first kids are dropped when they are approximately years of age.

Like sheep, Angora does reproduce once each year, coming heat in the late summer or early fall. The time of breeding termined largely by the projected climatic conditions, feed ly, and shelter at kidding time. Most range goats of this try are bred to kid in March and April, for mild, settled her and spring feed may normally be expected at this time.

DING:

Unfortunately, there is a widely prevailing popular belief goats will eat and do well on anything from newspapers to tin cans. This is erroneous. Like other animals that are gry or suffering from mineral or vitamin deficiencies, they develop depraved appetites and chew on many things; but prefer good quality, wholesome feeds and will pay dividends n so fed.

Goats are naturally browse animals; but a good goat range, ddition to furnishing abundant palatable evergreen brush cedar or other coniferous vegetation), should provide a mix- of grasses and broad-leaved herbs. On the most desirable ranges, this feed combination is available the year round, ough browse is usually the principal winter feed. When sup- ental feed is necessary, those feeds that are also suitable for p are used. The mineral (including salt) and water require- ts for goats are similar to those of sheep.

LTER:

It is essential that newly sheared goats be protected from rains and storms, no matter how simple the shelter may be; rwise losses are sometimes disastrous. Goat sheds are gen- y low structures, covered with a metal roof and boarded up ne or two sides. When well fed and not newly sheared, goats m succumb to cold and therefore do not need shelter.

E AT KIDDING TIME:

Goats require much more care than sheep at the time the orn are arriving. Young kids are much more delicate than g lambs—neither being able to endure so much cold or

damp weather nor to follow their mothers to the range so early in life. It is not surprising, therefore, to discover that an 80 per cent kid crop is considered excellent for range bands.

If heavy losses of young kids are to be averted, a safe system of kidding must be followed. The two most common systems of kidding followed by progressive and successful goat raisers of today are: (1) the toggle (or staking) system and (2) the pen (or corral) system.



Fig. 268. A toggle camp in which the young kids are staked near small A-shaped boxes. (Courtesy, U.S.D.A.)

THE TOGGLE SYSTEM

Under the toggle system, the young kids are staked with about fifteen inches of rope attached to a swivel on the stake end, with a loop on the other end being attached to the fetlock joint of the kid. This loop should be changed to another leg once daily. Each kid is provided with a box, usually a small A-shaped structure made of twelve-inch boards with one end open, which furnishes protection from the elements. The camp should have sufficient stakes and boxes to allow for as many kids as may be dropped within any ten-day period. Ten feet between stakes is considered about the right distance, providing sufficient space to avoid confusion, affording room for handling, and minimizing quarreling of the does. Whenever a kid is staked, it and its mother are branded with corresponding marks, thus avoiding any possibility of confusion in identity. Some ranchers clip the doe's tail and place the number there, whereas others place paint marks on similar body areas of the does and kids.

The ideal toggle camp should have a good slope for drainage. such a slope, the older does will spend the night on the er side; so their kids should be staked there, with the kids e younger does being placed in the lower part of the camp. urbance will be avoided if the kids or does that fight or ually overturn the kid boxes are placed at one end or corner e camp. On cold rainy nights, the does should be confined herwise kept out of the toggle camp; for each time a doe es through the yard to her kid, other kids will come out of boxes and suffer possible exposure.

A doe that disowns her kid should be staked with it. Kids usually be grafted if the foster mother and orphan kid are ed or penned together. The presence of "dogies," as orphan are known, is evidence that such details have not been given uate attention around a kidding camp.

The careful herder passes through the toggle camp each ing and evening, ascertaining whether each kid has nursed. kid is gaunt or restless, its mother should be brought to the ; if a doe has a distended udder, she should be taken to the r kids that carry the corresponding number or mark. Does extra large teats may have to be hand-milked until the kids learned to nurse the abnormally large teats.

Generally, kids should not be staked in the toggle camp for than ten days. At that time, they should be herded with mothers. Some of the large operators, especially those in western United States, release the kids directly from the e camp to the range with the does. These men insist that kids led in this manner develop into better foragers and possess muscle and bone. Others prefer to make the change from oggle camp to the range more gradually. Usually the latter ators first transfer the does and their kids in small numbers the toggle camp to a small field. The size of the field and is then gradually increased until the kid band may be turned e range when the young average about six weeks of age. odification of the latter system consists of confining the kids corral for a few weeks while the does depart via a "jump " (a structure about eighteen inches high) to forage on ange in the daytime.

PEN (OR CORRAL) SYSTEM

The pen or corral system is gaining in popularity, because work is involved in handling the animals and the results are od as those obtained by using the toggle system. For a herd

of 1,200 does the pen system usually involves having about eight corrals of ample size to enclose fifty does and their kids, a dozen small pens each large enough to hold an individual doe and her kid, and one or two larger corrals that may be adequate for four hundred to five hundred does and their kids.

Even the toggle system should be supplemented with a few individual kidding pens, which may be used as "bum pens" to force does to accept disowned kids of their own or orphan kids that are to be grafted. In general, in the pen or corral system about fifty does and their kids of about the same age group are kept in one pen or corral for the first two or three weeks; the kids are confined to the corral, whereas the does are permitted to go out to the range in the daytime. As the kids get older, groups are combined and turned to larger areas, eventually to travel to the range in a kid herd consisting of one thousand to twelve hundred does and their kids.

Goat Meat and Mohair

Goat meat tastes much like mutton or lamb of similar finish and quality, and it is equally appetizing and nutritious. In general, however, goat carcasses are not so well finished and do not yield as high a dressing percentage as average sheep carcasses.

Reputable meat dealers sell goat meat under the trade name of "chevon." Because of the unwarranted prejudice against goat meat by consumers, however, it may be true that some of this product is passed over the counter as mutton or lamb. There is no federal restriction against marketing it in the latter way, but in some cities and in the state of Oregon this practice is prohibited. Most chevon is marketed in the West, as efforts to dispose of this product in the East have met with little enthusiasm. More than any other kind of meat, goat meat needs effective and deserved publicity.

The production, handling and marketing of mohair has been fully covered in Chapter XXIV.

MILK GOATS

The goat has long been a popular milk animal in the Old World, where it is often referred to as the poor man's cow. When travelling or vacationing, Asiatics frequently take their goats with them in order to be assured of a supply of milk. Thus it is interesting to recall that the late Mahatma Ghandi of India took two milk goats with him on his last visit to England.

MILK AND BUTTERFAT PRODUCTION RECORDS OF THE DIFFERENT BREEDS OF MILK GOATS

Breed	Name and number of animal	Pounds produced	Date test started	Length of test	Owner
A. *Milk Production*					
Alpine (French)	Little Hill Pierette's Lady Penelope, *M, 47939, AR 499	4632.3	12/15/41	10 months	Mrs. F. N. Craver El Paso, Texas
Toggenburg	Sunshine Fink's LaHoya ****M, 61379, AR 813	4422.5	3/9/46	10 months	Mrs. J. D. Mantonye Albuquerque, New Mexico
Saanen	Three Oak's Blossom's Charmaine, 34288, AR 146	4161.7	2/13/31	9 months; 8 days	Mr. O. T. Hess Reedly, California
Nubian	Carmen Del Valle *M, 76837, AR 1159	3200.9	— 4 47	10 months	Mr. Pete DeMaggio San Fernando, California
B. *Butterfat Production*					
Alpine (French)	Yvonne Del Norte ****M, A81191, AR 1145	171.13	4/6/47	10 months	Mrs. F. N. Craver El Paso, Texas
Nubian	Carmen Del Valle *M, 76837, AR 1159	161.29	— 4/47	10 months	Mr. Pete De Maggio San Fernando, California
Saanen	Rio Linda Dona Marcelina *M, 65628, AR 736	153.69	12/15/46	10 months	Glen Daley Payson, Utah
Toggenburg	Sunshine Fink's LaHoya ****M, 61379, AR 813	151.97	3/9/46	10 months	Mrs. J. D. Mantonye Albuquerque, New Mexico

Milk goats were introduced to America in early times—th first settlers in the Virginia colonies bringing their milk goat from the mother country. However, improved strains were no imported until many years later, for the first purebreds said t have been brought into the United States were four Toggenburg imported to Ohio in 1893. Today the milk goat industry is grow ing, and these small animals are supplying nature's finest food— milk—to many children who would otherwise be undernourished They are especially well adapted for furnishing a milk supply fo low-income families in small towns and the suburbs of larg cities where there is not enough feed available for a cow. A do can often secure much of her feed from lawn clippings or garde and kitchen waste or by grazing in vacant lots.

A good milking doe will average two quarts of milk pe day over a lactation period of ten months, with superior animal producing as much as four to five quarts. The highest official tes on record in the United States was made by a French Alpine do that produced 4,632.3 pounds of milk in ten months. Milk an butterfat records of the different breeds are given in Table 51.

In comparison with cow's milk, goat's milk has smaller fa globules, a higher mineral content, and a sweeter flavor. Goat's milk forms a fine, soft curd during digestion, thus making it more easily digested than cow's milk for some children and for older people who cannot use cow's milk. If milked in clean quarters and away from the bucks, goat's milk will not have any unpleas ant flavor or odor. The strong odor of the buck is quickly ab sorbed by warm milk.

Four United States Breeds of Milk Goats

There are many distinct breeds of milk goats in the Ol World, but only four of these are important in the dairy business in America; namely, the Toggenburg, Saanen, Nubian, an French Alpine.

THE TOGGENBURG:

The Toggenburg ranks next to the Nubian in popularity i this country (based on current registration figures). It takes it name from the Toggenburg Valley in Switzerland, where its ori inated. Four animals of this breed were imported into Ohio i 1893, and five years later the United States Department of Ag riculture brought in sixteen more Toggenburgs. Other importa tions followed.

The Toggenburg is brown in color with two white strips o the face and white on the legs below the knees. Both sexes a



g. 269. A Toggenburg doe. The Toggenburg is brown in color with ite strips on the face and white on the legs below the knees. Both re polled. Wattles are characteristic. (Courtesy, U.S.D.A.)



g. 270. A Saanen doe. The most approved color for the breed is pure r creamy white. (Courtesy, U.S.D.A.)

usually hornless. Wattles are characteristic. The average doe wi weigh about one hundred pounds, with the bucks running cor siderably heavier. The breed is classed as hardy and versati in adaptation.

THE SAANEN:

The Saanen derives its name from the Saanen Valley Switzerland, its native home. Ten head of Saanen goats were im ported into this country by the United States Department o Agriculture in 1898. Other importations followed. The most ap proved color for the breed is pure white or creamy white. In siz they are larger than the Toggenburg, the does averaging on hundred twenty pounds in weight. Both sexes are usual hornless.

THE NUBIAN:

The Nubian is the most popular breed of milk goats in th country (based on current registrations). It is named fro the country of its origin in the upper Nile Valley. Legend ha it that the first Nubian goats, a present from the King Abyssinia to Napoleon III in the year 1860, were sent fro Africa to Europe to supply milk for a young hippopotamus. B cause these importations did not thrive in the English climat

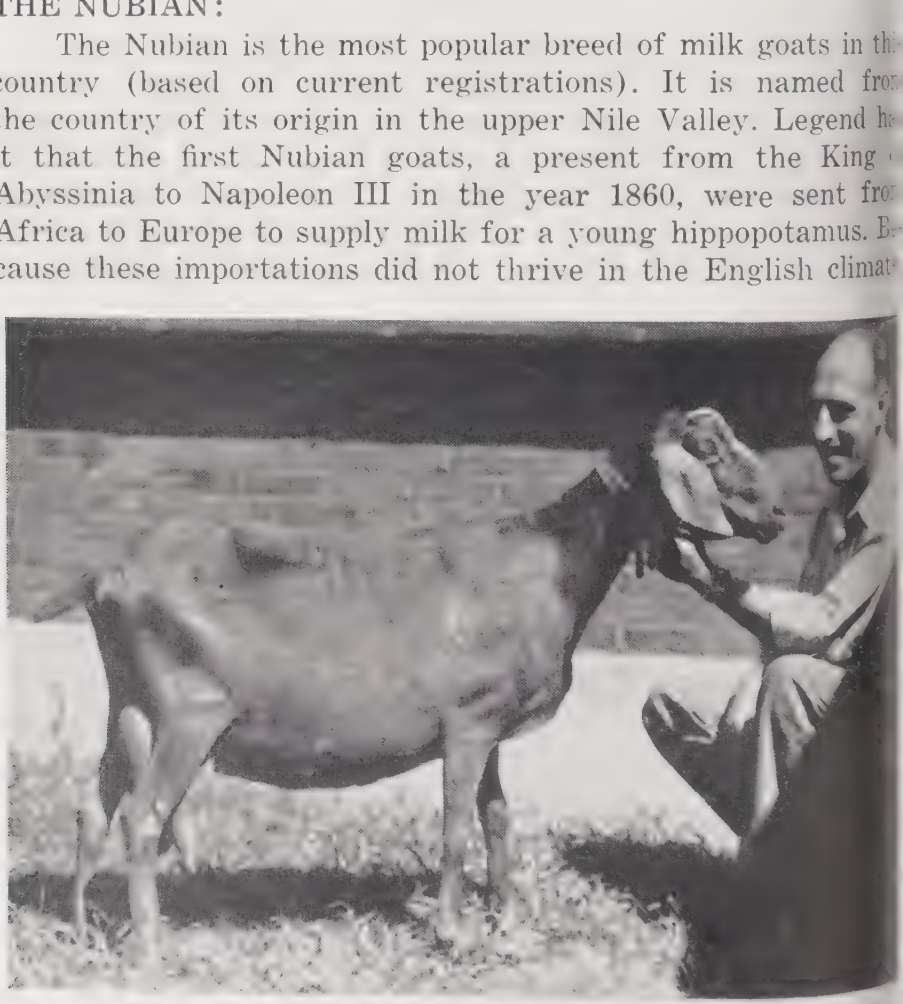


Fig. 271. A Nubian doe. The Nubian is characterized by a Roman nos and drooping ears. Both sexes are usually hornless, and the does are hor less. (Courtesy, U.S.D.A.)

were crossed with the native stock of the country. It is from crossbred foundation that the Nubian goats of the United s are descended, with the first importation occurring about

The Nubian is a large, distinctive looking goat with long ing ears and a turned-up tail. Both sexes are usually horn- and the does are beardless. There is a characteristic Roman and a prominent forehead. The hair is short and of a wide in color. Black and whites, tan and whites, red and whites ommon, but they may be any of these colors without white ings. A few are spotted or piebald. In general, Nubian does ot as heavy milkers as some of the other breeds, but the s very rich, the breed often being referred to as the "Jersey lk goats."



g. 272. French Alpine goat. This breed is noted for its size and dness. (Courtesy, U.S.D.A.)

FRENCH ALPINE:

The French Alpine is the newest of the breeds of milk goats introduced to America; all registered animals of the breed s country trace to an importation of three bucks and eight- oes made by Charles DeLangle of California in 1922. The developed in the mountains of France.

The French Alpines are large and rugged in build, and the does are good milkers. Their coats are multi-colored, with no standard markings. Some specimens of the breed have horns, whereas others are hornless. The breed is gaining in popularity in America.

Feeding Milk Goats

The feed requirements of milk goats are similar to those for sheep. These are set forth in Chapter XXII, with some specific feed allowances and suggested rations given in table 39. In feeding goats, however, one difference is recommended. Because of their higher milk production, lactating does should be fed more liberally than lactating ewes. Although the allowance should vary according to production, the concentrates for lactating does may consist of one and one-half to two pounds daily plus either (1) pasture in season, or (2) any of the roughage rations listed in table 39.

Reference

Added chapters on Sheep Management; Buildings and Equipment for Sheep; Sheep and Goat Health, Disease Prevention, and Parasite Control; Glossary of Wool Terms; and Selecting, Fitting and Showing Sheep are included in the following book by the same author and the same publisher as *Animal Science:*

Sheep Husbandry

CHAPTER XXVI

HISTORY AND DEVELOPMENT OF THE SWINE INDUSTRY[1]

Nomadic peoples could not move swine about with them as y as they could cattle, sheep, or horses. Moreover, close con- ent was invariably accompanied by the foul odors of the sty." For this reason, the early keepers of swine were often ded with contempt. This may have been the origin of the ew and Moslem dislike of swine, later fortified by religious pt. As swine do not migrate great distances under natural tions and the early nomadic peoples could not move them t easily, there developed in these animals, more than in most , a differentiation into local races that varied from place ace. It also appears that swine were domesticated in several rent regions and that each region or country developed a acteristic type of hog.

GIN AND DOMESTICATION OF SWINE

Most authorities agree that two wild stocks contributed to rican breeds of swine, namely, the European wild boar *scrofa)* and the East Indian pig (primarily *Sus vittatus)*. were gregarious, often forming large herds. Their feed con- d mostly of roots, mast (especially acorns and beech-nuts), such forage as they could glean from the fields and forests. use of their roving nature, diseases and parasites were st unknown.

In addition to these two stocks, there exist certain wild types g-like animals which, to this day, have never been domesti- l. Included in the latter group are the brightly colored trop- river pigs and the giant forest hog of Africa; the hideous hog of the African plains; the native American pigs (known eccaries); and the babirussa of Celebes, whose tusks re- le horns more than they do teeth.

Pigs were first domesticated in China in Neolithic times, t 4900 B. C. Biblical writings mention them as early as 1500

The author gratefully acknowledges the helpful suggestions of the ring well known swine authorities who reviewed Chapters XXVI gh XXXII: Professor E. F. Ferrin, Chief, Department of Animal Hus- y, University of Minnesota, St. Paul, Minnesota; and Mr. R. L. Pem- n, Secretary, Hampshire Swine Registry, Peoria, Illinois.

B. C., and legendary and historical accounts refer to the keeping of swine in Great Britain as early as 800 B. C. Swine seem to have been especially variable under domestication and especially amenable to human selection. As evidence of this assertion, one need but observe the difference in length of snout and size of ears of modern breeds of hogs.

When given the opportunity, pigs promptly revert within only a few generations to a wild or "feral" state in which they acquire the body form and characteristics of their wild progenitors many generations removed. The self-sustaining "razorback" of the United States is an example of this reversion.

European Wild Boar (Sus Scrofa)

The European wild boar *(Sus scrofa)* still lives in some of the forests of Europe. Although much reduced in numbers in the last few hundred years, it appears unlikely that the famous "wild boar" will become extinct like the aurochs (the chief progenitor of domestic cattle). In comparison with the domestic pig, this race of hogs is characterized by its coarser hair (with an

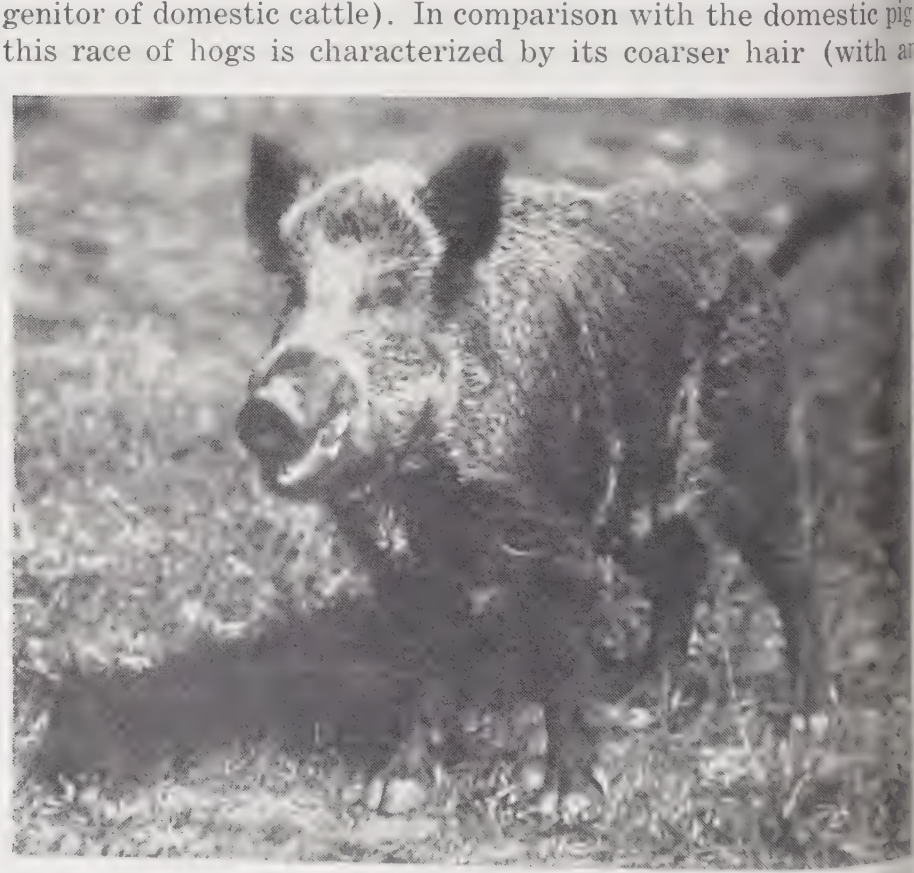
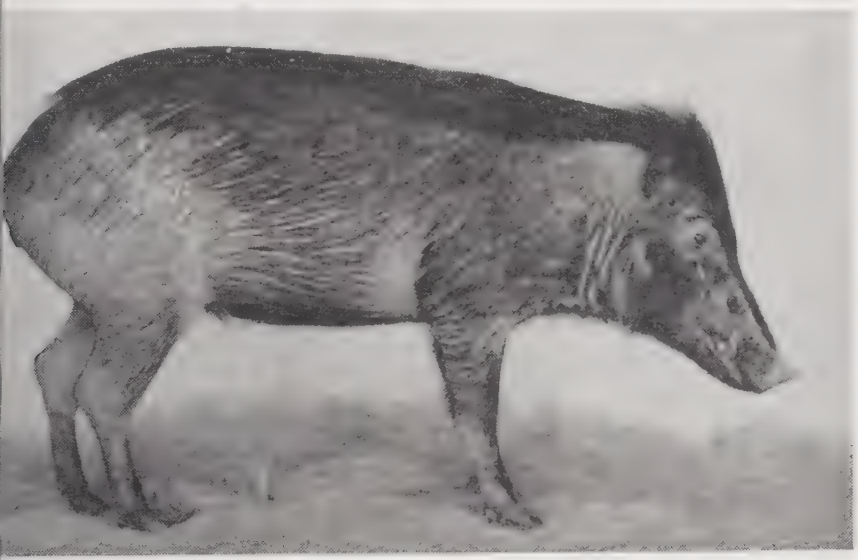


Fig. 273. European wild boar (*Sus scrofa*). Note the coarse hair, long head and snout, large feet, and long tusks. (Courtesy, New York Zoological Society.)

t mane-like crest along the back), larger and longer head, feet, longer and stronger tusks, narrower body, and greatlity to run and fight. The color of mature animals is nearly with a mixture of gray and rusty brown on the body. Very pigs are striped. The ears are short and erect.

hese sturdy ancestors of domestic swine are extremely geous and stubborn fighters and are able to drive off most eir enemies, except man. If attacked, they will use their with deadly effect, although normally they are as shy as



g. 274. Malayan or Philippine pig (*Sus philippinensis*). This animal er typical of all East Indian pigs, the wild stock which, along with ropean wild boar, contributed to American breeds of swine. In comh with the European wild boar, East Indian pigs are smaller and efined. (Courtesy, Chicago Natural History Museum.)

wild animals and prefer to avoid man. The wild boar hunt een regarded as a noble sport throughout history. Custom es that the hunt shall be on horseback and with dogs and he quarry shall be killed with a spear.

he European wild boar will cross freely with domestic , and the offspring are fertile. It was domesticated some- around the Baltic sea in Neolithic times.

Indian Pig

his broad classification includes a number of wild stocks of that were native to the East Indies and southeastern Asia. gh a bewildering number of domestic races are derived from ast Indian pig, including the domestic pig of China, all of

them are smaller and more refined than the European wild boar. The East Indian pig is further distinguished by the absence of the crest of hair on the back and a white streak along the sides of the face. It is thought that *Sus vittatus* was the chief, if not the only, race or species of the East Indian pig that was crossed with the descendants of the European wild boar in founding the American breeds of swine.

POSITION OF THE HOG IN THE ZOOLOGICAL SCHEME

The following outline shows the basic position of the domesticated hog in the zoological scheme:

Kingdom *Animalia*: Animals collectively. the animal kingdom.

Phylum *Chordata:* One of approximately twenty-one phyla of the animal kingdom.

Class *Mammalia:* Mammals or warm-blooded, hairy animals that produce their young alive and suckle them for variable period on a secretion from the mammary glands.

Order *Artiodactyla:* Even-toed, hoofed mammals.

Family *Suidae:* The family of nonruminant, artiodactyl ungulates, consisting of wild and domestic swine but, in modern classifications, excluding the peccaries.

Genus *Sus:* The typical genus of swine, formerly comprehensive but now restricted to the European wild boar and its allies, with the domestic breeds derived from them.

Species *Sus scrofa* and *Sus vittatus: Sus scrofa* is a wild hog of continential Europe from which most domestic swine have been derived. *Sus vittatus* was the chief, if not the only, race or species of the East Indian pig that contributed to present-day domestic swine.

INTRODUCTION OF SWINE TO AMERICA

Although many wild animals were widely distributed over the North American continent prior to the coming of the white man, the wild boar was unknown to the native American Indian.

Columbus first brought hogs to the West Indies on his second voyage in 1493. According to historians, only eight head were landed as foundation stock. However, these hardy animals must have multiplied at a prodigious rate, for thirteen years later, the

rs of this same territory found it necessary to hunt the ious wild swine with dogs; they had grown so numerous they were killing cattle.

Although swine were taken to other Spanish settlements ving the early explorations of Columbus, pigs first saw ica when touring the continent with Hernando de Soto. The etic Spanish explorer arrived in Tampa Bay (now Florida) 39. Upon his several vessels (between seven and ten), he ix hundred or more soldiers, some two hundred or three red horses, and thirteen head of hogs.



g. 275. A typical Arkansas "razorback." This two-year-old sow d 180 pounds. (Courtesy, United Duroc Record Association.)

his hardy herd of squealing, scampering pigs traveled with rmy of the brave Spanish explorer. The hazardous journey hed from the Everglades of Florida to the Ozarks of Mis- In spite of battles with hostile Indians, difficult travel, and hardships, the herd thrived so well that at the time of De death on the upper Mississippi, three years after the land- t Tampa, the hog herd had grown to seven hundred. o's successor, Moscoso, then ordered that the swine be auc- l off among the men.

t is reasonable to assume, therefore, that the cross-country of De Soto's herd of pigs was the first swine enterprise in ica. No doubt some of De Soto's herd escaped to the forest,

and perhaps still others were traded to the Indians. At any rate this sturdy stock served as foundation blood for some of our early American "razorbacks."

COLONIAL SWINE PRODUCTION IN THE UNITED STATES

The colonists must have imported hogs from the mother country at a very early date, for one of the historical documents of 1633 refers to their innumerable swine. It is also noted that

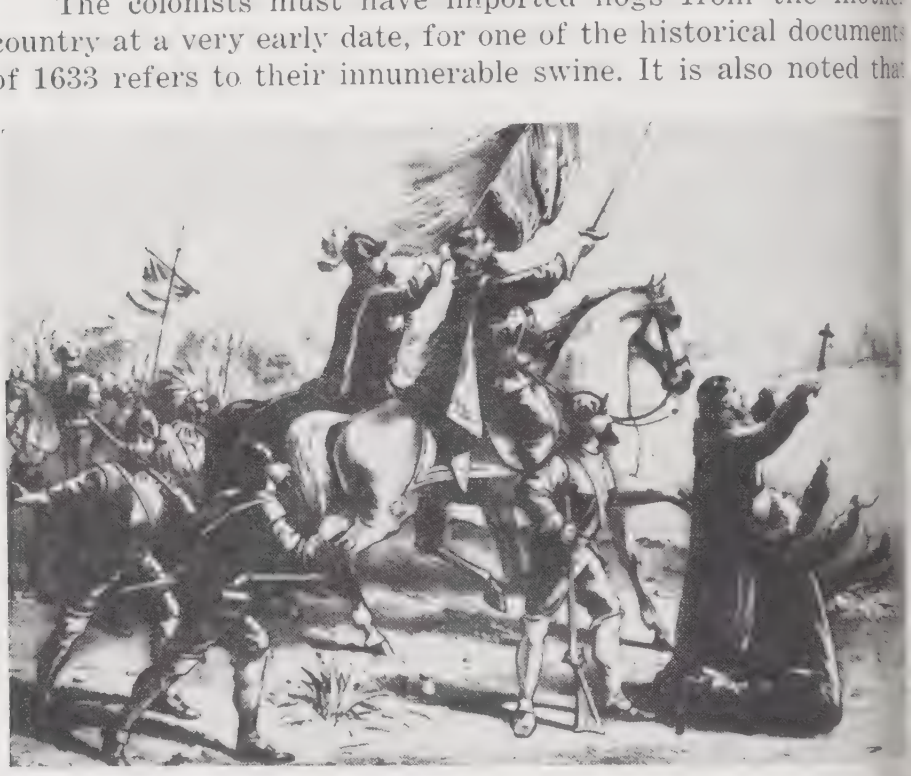


Fig. 276. DeSoto discovers the Mississippi. When, in 1539, the Spanish explorer landed at Tampa Bay (now Florida) he brought with him 13 head of hogs. At the time of DeSoto's death on the upper Mississippi, three years after the landing at Tampa, the hog herd had grown to 700. (Courtesy, The Bettmann Archive.)

John Pynchon, an early-day packer of Springfield, Massachusetts, bought and packed (barrelled) great numbers of hogs for the West Indian trade between 1662 and 1683. In general, this pork was exchanged for sugar and rum. Pynchon's records indicate something about the hogs in the early New England Colonies. They were described as black or sandy in color, with razorback build; and they were said to be speedy runners (as might be inferred from the fact that they ranged the woods in a half-wild state). The boars were believed to be quite capable, with their huge tusks, of taking care of any wolves that might attack them. Pynchon's book records the weight of one lot of 162 hogs

) pounds, an average of only 170 pounds per animal. Sixteen ese weighed less than 120 pounds. Twenty-five weighed than 200 pounds; and the two heaviest tipped the scales) and 282 pounds, respectively. Others followed Pynchon's n packing pork, and in the year of 1790, it was reported ix million pounds of pork and lard were exported from the d States.

Jnlike the cattle, sheep, and horses—which were largely ed to the town commons for pasturage—the hogs of early England roamed the surrounding countryside. Many of them caught by hound dogs at marketing time. Usually a dog n to each ear of the hog until the animal could be tied and d into a properly enclosed wagon. In order to prevent too damage from rooting, some of the New England towns nated a "hog-ringer," whose duty it was to ring all swine a certain height (Hadley, Massachusetts, drew the line at en inches). Few hogs were marked, for these animals were merous that nobody minded the theft of a pig. The only ver given the hogs, and then infrequently, was at farrow-me, at which time the sow might be given the privilege of a shelter or be allowed to crawl under the barn or house.

CREATION OF AMERICAN BREEDS OF SWINE

The most thoroughly American domestic animal is the hog. other class of animals have so many truly American breeds reated. These facts probably result (1) from the suitability ive maize or Indian corn as a swine feed, (2) from the ease which pork could be cured and stored prior to the days rigeration, and (3) from the need for fats and high-energy for laborers engaged in the heavy development work of a er country.

Jnlike the beef and dairy stockmen, who sent their native to slaughter and imported whole herds of blooded cattle England, the American hog raiser was content to use the rel sow descended from colonial ancestry as a base, upon he crossed imported Chinese, Neapolitan, Berkshire, Tam-, Russian, Suffolk Black, Byfield, and Irish Grazier boars. importations began as early as the second quarter of the enth century. Out of the various crosses, which varied area to area, were created the several genuinely American s of swine.

tructurally, the creation of the modern hog has been that veloping an animal that would put flesh on the sides and

quarters, instead of running to bone and a big head. Physiologically, breed improvement has resulted in an elongation of the intestine of the hog, thus enabling him to consume more feed for conversion into meat. According to naturalists, the average length of the intestine of the wild boar compared with his body is in the proportion of 9 to 1; whereas, in the improved American breeds, it is in the proportion of 13.5 to 1.

THE RISE OF CINCINNATI AS A PORK-PACKING CENTER

With the expansion of farming west of the Allegheny Mountains, corn was marketed chiefly through hogs and cattle. At the time of the first United States Census, taken in 1840, the important hog-production centers were in what were then the corn growing areas of Tennessee, Kentucky, and Ohio.

Cincinnati became the earliest and foremost pork-packing center in the United States. By 1850, it was known throughout the length and breadth of the land as "Porkopolis". Cincinnati originated and perfected the system that packed fifteen bushels of corn into a pig, packed that pig into a barrel, and sent him over the mountains and over the ocean to feed mankind.

Some idea relative to the rapid rise in pork slaughtering in Cincinnati and the price fluctuations of the period may be gained from Table 52.

TABLE 52

NUMBER OF HOGS SLAUGHTERED AND PRICES ON THE CINCINNATI MARKET, 1833-67

Year	Number of hogs slaughtered	Year	Price cwt.
1833	85,000	1855	$ 5.7
1838	182,000	1860	6.2
1843	250,000	1862	3.5
1853	360,000	1865	14.6
1863	606,457	1866	11.9
		1867	6.9

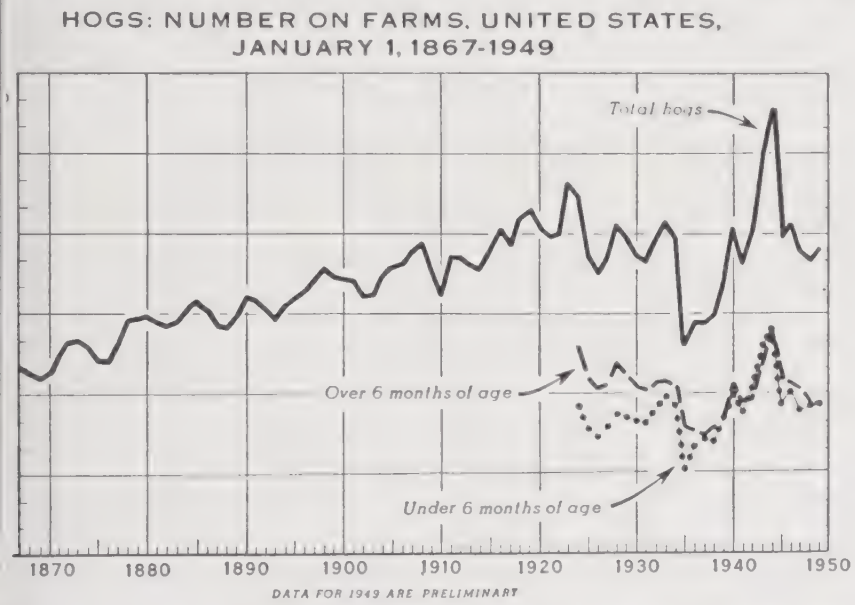
Cincinnati was favored as an early-day, pork-packing center because (1) it was then the center of the finest hog-raising region in the world, and (2) it was strategically located from the standpoint of shipping, large quantities of cured pork being shipped to southern points in flat boats via the Ohio and Mississippi rivers. Both pork and lard were exported to the West Indies, England, and France.

The inflated price of 1865 and the slump of two years later the result of the demands caused by the Civil War. History ted itself during and following World War I.

By 1860, the center of pork production and packing was shifted westward, and Chicago became the foremost packnter, a position it has retained to this day.

WTH OF THE UNITED STATES SWINE INDUSTRY

The growth of hog production has paralleled very closely the ction of corn in the north central or Corn Belt states, as f the United States corn crop is normally fed to hogs, and



g. 277. Growth of the United States swine industry, 1867 to 1949. n hog numbers have changed rather sharply from year to year, the me trend shows a gradual increase. (Courtesy, U.S.D.A., Bureau of ltural Economics.)

states produce nearly three-fourths of the corn grown in ountry. Thus, when corn yields are down, the price of feed and swine production decreases. The opposite occurs when yields are high.

As shown in Figure 277, hog numbers change sharply from to year. Except for the sharp increase during the war years, has been a tendency to decrease numbers since 1923. This e has probably been the result, in part at least, of decreased t demands for pork and pork by-products and of the ined competition that lard has encountered from vegetable

SWINE IN WORLD WAR II

Swine numbers reached an all-time peak of 83,741,000 head on January 1, 1944. Total hog numbers averaged 37.3 per cent greater during the war period (1941 to 1945) than during the pre-war years (1936 to 1940). These expanded war-time numbers were also accompanied by increased efficiency of production—the swine producers practicing those improved breeding, feeding, and management practices that had been gained through the preceding years of practical experience and scientific experimentation.

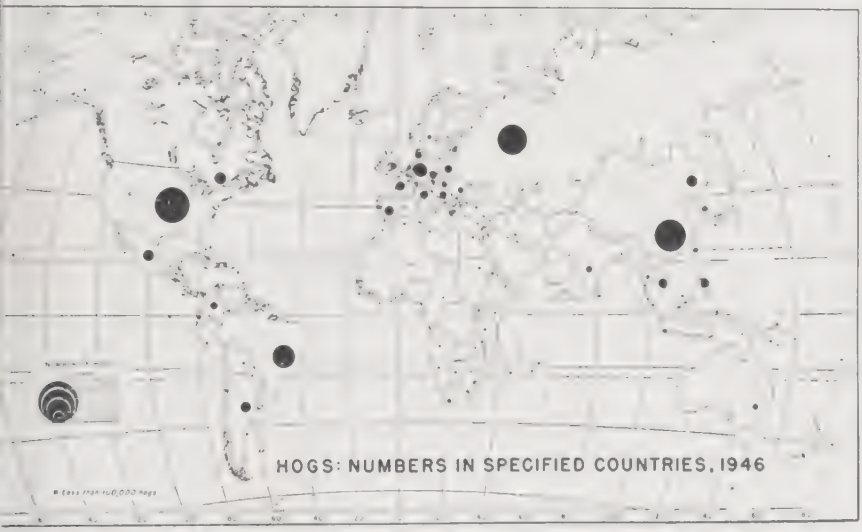
CHAPTER XXVII

DISTRIBUTION, ADAPTATION AND THE FUTURE OF THE SWINE INDUSTRY

Swine are produced most numerously in the temperate zones n those areas where the population is relatively dense. There son to believe that these conditions will continue to prevail.

LD DISTRIBUTION OF SWINE

Table 53 shows data pertaining to the ten leading swine-pro- g countries of the world. China has long had the largest hog ation, but because of the large human population, produc-



g. 278. World distribution of swine, 1946. (Courtesy, U.S.D.A., Office reign Agricultural Relations.)

n that country is largely on a domestic basis, with very gible quantities of pork entering into world trade. It must e remembered that in China pigs are primarily scavengers hat the value of the manure produced is one of the main tives for keeping them.

Prior to World War II, the United States, Denmark, Canada, rish Free State, the Netherlands, and Poland were the prin- pork-surplus producing nations. Great Britain, Germany, ce, and Belgium were the principal deficit countries. Imports

TABLE 53

SIZE AND DENSITY OF HOG POPULATION OF TEN LEADING HOG-PRODUCING COUNTRIES OF THE WORLD, BY RANK

Country	No. of hogs[1] (thou.)	When esti-mated[1]	Human popula-tion[2] (thou.)	Hogs per capita	Area[2] (thou.) (sq. mi.)	Hogs per sq. mi.
China	59,000	1947	491,000	0.12	4,457	13.24
United States	55,028	1948	142,656	0.39	3,620	15.20
Brazil	23,000	1948	48,000	0.48	3,300	6.97
Russia	8,600	1947	182,364	0.05	9,442	0.91
Germany	7,800	1948	66,000	0.12	137	56.93
France	5,678	1948	40,830	0.14	213	26.66
Canada	5,381	1948	12,307	0.44	3,700	1.45
Mexico	5,314	1947	22,226	0.24	769	6.91
Spain	4,676	1946	27,000	0.17	197	23.74
Philippine Islands	4,349	1936-40	16,386	0.27	115	37.8[illegible]
World Total	245,600	1948	2,170,200	0.11	51,235	4.7[illegible]

[1] *Agricultural Statistics*, U. S. Dept. of Agri., 1949, pp. 364-5.
[2] J. Whitaker, *Whitaker's Almanac for 1948*, London, England, pp 193-198.

of pork by England usually exceed those of all other European countries combined.

In general, in the European countries, hog numbers are closely related to the development of the dairy industry and the production of barley and potatoes—in much the same manner as the distribution of swine in the United States is closely related to the acreage of corn.

Corn is raised extensively in the La Plata region of South America and in the Danube Basin of southern Europe. In these corn-growing areas, hog production is a dominant type of farming.

Dairy by-products—skim milk, buttermilk, and whey—have long been important swine supplements in northeastern United States and also in Denmark, Holland, Canada, Ireland, Sweden and Latvia. In Germany and Poland, potatoes have always been extensively used in swine feeding.

Since 1923, except for the increases occurring during World War II, there has been a downward trend in the exports of pork and lard from the United States. This has been due to a marked increase in production in the European countries, particularly in Denmark, Germany, and Canada and to various trade restrictions imposed by the importing countries. In no sense has the

ease been due to any lack of capacity to produce on the part ıe American farmer.

World hog numbers at the beginning of 1949 were estimated pproximately 261 million head, which is 29 million head below five-year, 1936 to 1940, average. Hog numbers fluctuate er sharply on the basis of available feed supplies. The post- swine production of Denmark appears to be held down by shortage of feed grains, the increase in other production s, inadequate export prices, and the fact that Canada appears e taking over the London market.

The annual per capita consumption of pork in different tries of the world varies directly with production and avail- ty, cost, the taste preference of the people, and in some cases the religious beliefs that bar the use of pork as a food.

NE PRODUCTION IN THE UNITED STATES

The contribution of the humble pig to American agriculture pressed by his undisputed title as the "mortgage lifter." No r animal has been of such importance to the farmer. Out of ıational total of nearly six million farms, about four million hogs; and upon these farms, 20 per cent of the world's ly of pork is produced.

On January 1, 1948, there were 55,028,000 head of hogs in United States.[1] Hogs ranked second only to cattle in animal lation. Hogs also rank as one of the most important sources ırm income, being exceeded only by cotton, dairy products, e, and wheat. Of the average annual production of 22.5 bil- pounds of meat during the five war years, 1941 to 1945, one- was pork. To be more exact, 50 per cent was pork, 39 per beef, 6 per cent veal, and 5 per cent lamb and mutton. The capita consumption of pork in the United States during the prewar years, 1935 to 1940, averaged 60.9 pounds; whereas ng the war, 1941 to 1945, it was increased to 67.5 pounds, ıcrease of 10.8 per cent. The consumption of pork is higher e United States than in any other country of the world.

ıs of Swine Production

The geographical distribution of swine in the United States ely coincides with the acreage of corn, the principal swine . Normally, one-half of the corn crop is fed to hogs. It is not rising, therefore, to find that more than one-half of the hog

[1] *Agricultural Statistics*, U. S. Dept. of Agri., 1949, p. 364.

production is centered in the seven Corn Belt states: Iowa, Illinois, Indiana, Ohio, Missouri, Nebraska, and Kansas. From this it should not be concluded that sections other than the Corn Belt are not well adapted to pork production. As a matter of fact, an area that produces dairy by-products, small grains, and forage is admirably adapted to the production of bacon of the highest quality. According to the census of 1940, 54 per cent of the hogs were in the Corn Belt states, 22 per cent in the South, and the other 24 per cent in the Dairy Belt and other northern and northeastern sections and in the western states.

Since 1920, there has been a significant increase in pork production in the northwestern Corn Belt and in the northern and western Great Plains area. This has been attributed to the increased corn and barley production in these areas.

The eastern, New England, and western states of the United States are pork deficit areas. Despite the greatly expanded human population of the Pacific Coast, it is noteworthy that hog numbers in this area have remained about the same since 1900. During the seven-year period, from 1940 to 1947, the human population of the nine-state area—consisting of California, Oregon, Washington, Idaho, Montana, Utah, Nevada, Arizona, and New Mexico—increased by 25.1 per cent; whereas the population of the United States as a whole merely increased by 8.9 per cent. In 1947, there was an estimated deficit of 52.8 per cent in pork and 12 per cent in all meats in this same nine-state area. Also approximately 349,440 tons of dressed, canned and cured meats, plus an additional 1,631,289 hogs on foot, were shipped into these nine states.

Many of the live hogs slaughtered in the West Coast plants today are shipped distances of 1,500 to 2,000 miles. They are being transported greater distances on foot than was necessary a century ago when the eastern packers were prompted to move their slaughtering plants from the East Coast to Chicago.

Leading States in Swine Production

The state of Iowa has held undisputed lead in hog numbers since 1880, but the rank of the other states has shifted about considerably. A ranking of the ten leading states, together with total numbers for the United States is given in Table 54.

Probably 90 per cent of the commercial pork supply is produced in the Corn Belt. Growing corn and producing pork have contributed largely toward making the farmers of the upper Mississippi Valley the wealthiest agricultural people on the globe

TABLE 54

TEN LEADING STATES IN HOG NUMBERS, BY RANK 1949, WITH AVERAGES FOR 1944-1948[1]

State	Number of Hogs	
	Average 1944-48 (Thousands)	1949 (Thousands)
	11,504	10,836
ois	6,241	5,714
ana	4,294	4,192
ouri	4,026	3,851
esota	3,888	3,331
	3,327	3,054
raska	3,000	2,403
s	2,134	1,701
onsin	1,842	1,650
ucky	1,514	1,619
ed States Total	63,264	57,128

Livestock Market News, Statistics and Related Data, 1947, U. S. Dept. ri., July, 1948, p. 2.
Ibid., 1949, August, 1950, p. 2.

ATION OF SWINE PRODUCTION TYPES OF AGRICULTURE

With cattle and to a lesser extent with sheep, there is con- able "two-phase production" in which the young are pro- d on the ranges of the West and then shipped to the Corn as feeder animals to be fattened out on grain. Because of greater disease and shipping hazards and the fact that all es of swine—mature breeding stock, the growing pig, and attening animal—require much the same kind of feed, the lete process of farrowing and fattening hogs is usually ed out on the same farm. Even so, there is considerable tation of swine production to the varied types of agriculture d in different sections of the United States, especially from tandpoint of types of feeds utilized.

Corn-Hog Relationship

With the opening up of the central Mississippi Valley region, on became evident that here was one of the greatest corn tries in the world. The fertile soil, relatively long growing on, ample moisture, and warm nights were ideal for corn uction. Then it was soon realized that corn was a hog feed rpassed. Here appeared to be an invincible combination, but,

unfortunately, the early-day hog proved quite incompetent in the efficient conversion of corn into meat and lard. Undaunted, the swine producers of America promptly set about improving the existing swine, eventually developing several newly created and distinctly American breeds. Thus "King Corn and the American hog" have played no small part in the development of American agriculture and in the prosperity of our farmers. The hog created a channel of disposal or market for corn and supplied the people of this and other countries with highly palatable and nutritious meat at a moderate price.

Despite the adaptation of the Corn Belt for the production of corn and the suitability of this crop as the chief ingredient of swine rations, the virtues of a balanced type of farming in a mature agriculture have been shown by years of experience and scientific findings. Thus, more and more Corn Belt farmers are diversifying their farm enterprise, with proper land use receiving paramount consideration. Other crop and livestock enterprises have been added to the corn-hog combination.

The Hog and Beef Combination

Farmers in the Central States long ago recognized the advantages of combining beef cattle and hogs. Regardless of the system of beef production—cow and calf proposition, the growing of stockers and feeders, fattening steers, dual-purpose production, or a combination of two or more of these systems—the beef cattle and swine enterprises compliment each other in balanced farming.

The cattle are able to utilize effectively great quantities of roughages, both dry forages (hay, fodder, etc.) and pastures, whereas the pig is fed primarily on concentrates. Moreover, hogs profitably salvage waste grains from the droppings of fattening cattle. In brief, the beef cattle-hog combination makes it possible to market efficiently all the forages and grains through livestock with the manure being available for application back on the land. Such a combination makes for excellent distribution of labor. The largest labor requirements for both beef cattle and hogs comes in the winter and early spring. During the growing and harvesting seasons, therefore, most of the labor is released for attention to the crops.

The Hog and Dairy Combination

Where whole milk is marketed, it is doubtful if there is any advantage to be gained from combining hog raising with dairy

On the other hand, where cream or butter is sold and the
milk or buttermilk is available, the hog-dairy cattle combi-
on is usually a very profitable one. No finer protein supple-
for pigs can be obtained than that afforded by the milk
roducts. A swine ration consisting of grain and skim milk
uttermilk produces excellent results when fed to pigs on good
ure; for the green forage provides an abundance of carotene
amin A), and the exposure to direct sunlight provides vita-
D requirements. A well-cured, green, leafy legume hay should
sed for pigs not on pasture.

ne Production In The South

In recent years, there has been a concerted effort to diversify
agriculture of the South away from the straight cotton, pea-
and tobacco farming traditional to the area. In part, this
ement has been motivated by the recognized need for greater
ntion to improved soil conservation practices and the unprof-
e prices often encountered from the sale of cotton, peanuts,
bacco.

The southern states are by no means uniform in the crops
they grow. A great variety of suitable swine feeds are pro-
d from area to area. The common hog feeds of the South
ude corn, peanuts, soybeans, velvet beans, sweet potatoes,
asses, cottonseed meal, some small grains, and numerous
ing crops. From the standpoint of pastures, the South has
unique advantage of possible year-around grazing, particular-
hen permanent pastures are properly supplemented with
ted temporary grazing crops.

ne Production In the Far-West, Including Irrigated Areas

As has already been pointed out, the far west is a swine
it area. This is largely due to the fact that other enterprises
been more remunerative; and, over a long period of time,
ners and ranchers do those things which are most profitable
hem. Moreover, in the far West, wheat, the leading grain
of the area, is frequently too high in price to use profitably
swine feed. This is due to the fact that wheat has always
considered primarily a human cereal and that it was feder-
subsidized during the depression years.

On the other hand, there are some factors that are extremely
rable toward increased swine production in the far West.
se are as follows:

1. **Freight differential.**—It is estimated that the increased costs—freight, shrinkage, death losses, feed, extra handling charges, etc.—involved in shipping live hogs from the northwest Corn Belt and the northern and western Great Plains area to Pacific Coast slaughtering plants may amount to $1.50 to $2.00 per hundredweight on foot. The costs involved in shipping carcass meats, because of favorable freight rates, is less, but even this charge represents a sizeable figure. Thus, the hog markets of the West usually have a higher top than those of the Corn Belt, although in the past this has not been equivalent to the freight differential.

2. **Quality of pork.**—As is generally known, Denmark's claim to producing the highest quality of bacon in the world has been attributed to the small grains and dairy by-products used as swine feeds. Similar feeds are abundantly available in the far west. Thus, when and if hogs are bought on a carcass quality basis, the far west should be in a unique position, provided that intelligent and progressive breeding, feeding, and management accompany the movement.

3. **Increased irrigation.**—Irrigated areas are steadily increasing in the western states. Historically these irrigated projects have available for swine feeding an abundance of alfalfa, dairy by-products, some corn and potatoes, and numerous cheap by-product feeds. With an increase in irrigated areas in the West, it is quite likely that swine production will expand. It should also be pointed out that scientific investigations now point to the possibility, and even the desirability, of including larger quantities of alfalfa hay in winter swine rations, especially those for mature breeding animals.

4. **A mature agriculture.**—A mature agriculture is usually accompanied by greater diversification, more stability, and justifiable attention to soil conservation practices. It seems quite likely that the farmers and ranchers of the West will, in the future, do less straight grain farming and broaden the livestock enterprise to include more than either sheep or cattle.

FACTORS FAVORABLE TO SWINE PRODUCTION

The important position that the hog occupies in American agriculture is due to certain factors and economic conditions favorable to swine production. These may be enumerated as follows:

1. Swine excel all other farm animals in the economy with

ch they convert concentrated farm feed into meat and meat ucts.

At the Washington Agricultural Experiment Station, data n from various experiments indicate that the feed required roduce gain in the dry lot during the market-finishing period attle, lambs, and pigs is about as follows:

e and class of animals	Days on feed	Feed required per 100 lbs. gain	
		Grain	Hay
rling steers	200	785	225
ler lambs	90	440	460
wing-fattening pigs	90	450	

2. Swine are prolific, commonly farrowing from six to ve pigs, and they will produce two litters per year.

3. Swine excel in dressing percentage, yielding 65 to 80 per of their live weight when dressed "packer style"—with head, fat, kidneys, and ham facings removed. On the other hand, le dress only 50 to 60 per cent, and sheep and lambs 45 to 55 cent. Moreover, because of the small proportion of bone, the entage of edible meat in the carcass of the hogs is greater.

4. Pork is most nutritious. Because of the higher content of and the slightly lower content of water, the energy value of is usually higher than that of beef or lamb.

5. Hogs are efficient converters of wastes and by-products pork. This includes grain wasted by fattening cattle, gar-e, garden waste, and such dairy by-products as skim milk.

6. Since hogs are well adapted to the practice of self feed-labor is kept to a minimum.

7. Swine require a small investment for buildings and equip-t.

8. The pig is adapted to both diversified and intensified culture.

9. The initial investment in getting into the business is ll, and the returns come quickly. A gilt may be bred at eight ths of age, and the pigs can be marketed six months after owing.

10. The spread in price in market hogs is relatively small—h smaller, for example, than the spread which usually exists veen the price of prime steers and canner cows. Hogs may be at weights ranging from 150 to 300 pounds without any

great penalty in price. Also, old sows that have outlived their usefulness in the breeding herd may be disposed of without difficulty.

11. Hogs are unexcelled as a source of farm meats. This is due to their ease of dressing and the superior curing and keeping qualities of pork.

12. The hog excels all other farm animals in fat storing ability, and pork fat is more valuable than fats produced by other domestic animals.

FACTORS UNFAVORABLE TO SWINE PRODUCTION

It is not recommended that hogs be raised under any and all conditions. There are certain limitations that should receive consideration if the venture is to be successful. Some of these reservations are as follows:

1. Because of the nature of the digestive track, the growing-fattening pig must be fed a maximum of concentrates and a minimum of roughages. Where or when grains are scarce and high in price, this may result in high production costs.

2. Swine are very susceptible to numerous diseases and parasites.

3. Fences of a more expensive kind are necessary in hog raising.

4. Sows should have skilled attention at farrowing time.

5. Because of their rooting and close-grazing habits, hogs are hard on pasture.

6. Hogs are not adapted to a frontier type of agriculture where grazing areas are extensive and vegetation is sparse. Neither are they best suited to the utilization of permanent pasture areas.

THE FUTURE OF THE AMERICAN SWINE INDUSTRY

During World War II, there was an unprecedented demand for all meats and fats, available feeds being the only limiting factor. United States per capita civilian consumption of pork increased from a prewar (1936 to 1940) average of 60.9 pounds to a wartime (1941 to 1945) average of 67.5 pounds, representing an increase of 10.8 per cent.[1] Lard production, likewise, was greatly expanded during the war years; finding outlets through

[1] *Livestock, Meats, and Wool Market Statistics and Related Data*, 1946. U. S. Dept. of Agri. Production and Marketing Administration Mimeographed Pamphlet, p. 76.

ased civilian consumption, the armed forces, and export r lend-lease.

The per capita civilian consumption of lard increased from ewar (1936 to 1940) average of 12.1 pounds to a wartime 1 to 1945) average of 14.6 pounds, representing a 20.6 per increase.[1] A part of the increased production and utilization rd was without doubt due to the development of a more e "war style" lard. This involved the addition of a certain entage of hydrogenated oils to raise the melting temperature e product and, for tropical shipments, the addition of lecithin duce oxidation and consequent rancidity of lard under conns of high temperatures.

Thus pork and lard fared well during the war years. In gen- they have continued to be in demand during the postwar d, but no one is of the opinion that this situation will con- indefinitely.

Some of the factors that will determine the future of the rican swine industry are as follows:

1. **Foreign competition.**—With the return of more abundant cheaper feeds, Denmark, the Irish Free State, the Nether-s, and Poland are again likely to become pork-exporting ons. Moreover, some of the South American countries are ntial pork-producing and pork-exporting nations, an encour- market being the only needed incentive. Already, Canada aking great progress in its all-out efforts to capture the lon market. Only tariffs, quotas, and embargoes enacted by federal government can prevent future and serious competi- from foreign imports. However, with our huge corn produc- and improved swine-production methods, it is not anticipated pork will ever have the potential foreign competition that s with beef.

The potential pork-export situation is not encouraging. d-lease and postwar demands for both pork and lard should e misleading. These are only temporary, lasting only so long eds are scarce in some of the war-torn countries.

During the prewar years, 1936 to 1940, the United States rted an average of only 148 million pounds of pork (exclud- ard); whereas during the war years, 1941 to 1945, this was

[1] *Livestock, Meats, and Wool Market Statistics and Related Data*, U. S. of Agri., 1945-46; and *The National Food Situation, 1945*, U. S. Dept. ri., Bur. of Agri. Econ. Situation Rpt., July, 1945.

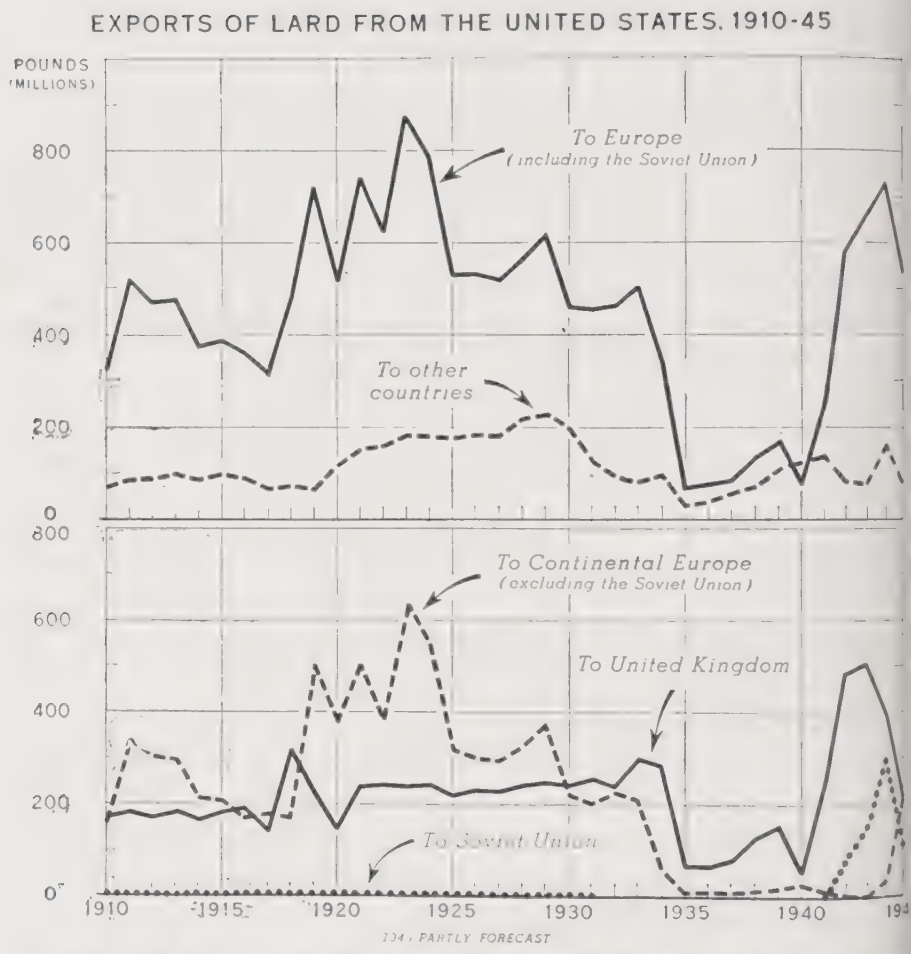


Fig. 279. Exports of lard from the United States, 1910 to 1945. Note that lard exports increased sharply during both World War I and World War II, but they were very small between 1935 and 1940. Most authorities agree that future lard exports will be negligible. (Courtesy, U.S.D.A., Bureau of Agricultural Economics.)

increased to an average of 1,394.9 million pounds, representing an increase of 842.5 per cent.[1]

2. **The lard situation.**—Lard was a "drug on the market" prior to 1941, and, soon after World War II, this status returned. Satisfactory vegetable oils can now be produced at lower cost. When processed lard sells for less than the price of hogs on foot, it should be perfectly evident that the product is lacking in demand. In order to alleviate the surplus lard situation it would appear that the soundest approach might consist of: (1) breeding a type of hog that is less "lardy" in conformation

[1] *The Livestock and Wool Situation*, U. S. Dept. of Agri., Bur. of Agr. Econ. Situation Rpt., May-June, 1946, p. 16.

feeding so as to produce less excess fat, (3) marketing at er weights, and (4) purchasing hogs on a quality basis ferably rail-graded).

3. **Increased human consumption.**—Without doubt some ased human consumption of pork could be brought about ugh the production of a higher quality product. Many folks, example, would relish more high quality breakfast bacon. It ot anticipated, however, that any considerable opportunity ncreased demand for hogs will come from any marked in- se in home consumption of pork.

4. **Competition from other farm animals and between areas.** espite the efficiency with which the pig converts grain to , he must continue to compete with all classes of animals for available concentrates. For the nation as a whole, it appears, ever, that there exists a fair balance of production with con- ption of the several products of domestic animals. Thus no ediate or sizeable shift that would be either favorable or vorable to increased pork production is anticipated. On the r hand, certain minor shifts in production from area to area be expected.

Because of the greatly increased human population on the fic Coast, and the recognition that the small grains produced ne area are ideally suited to the production of high quality , favorable factors exist for increased swine production in area. This is especially true if a superior and quality con- us market is developed.

Because of the year-around grazing, interest in diversifica- and the diverse and comparatively cheap feeds in the south- states, increased swine production in this area would appear e in the offing.

CHAPTER XXVIII

TYPES AND BREEDS OF SWINE

Swine types are the result of three contributing factors: (1) the demands of the consumer, (2) the character of the available feeds, and (3) breeding and the pursuit of type fads by breeders.

THE TWO TYPES OF HOGS

Prior to 1925, the principal U. S. breeds of hogs were logically classified as either "lard type" or "bacon type." Subsequently, the former lard type breeds generally have been bred and selected for greater length of body and less fat. As a result, modern representatives of these breeds are intermediate in type between the true lard and bacon types. Correctly speaking, they are "meat type" rather than lard type hogs. Although the lard type connotation persists, and its historical significance is appreciated, herein the author accedes to the modern trend in swine breeding in recognizing and classifying present-day breeds of swine as either (1) meat type or (2) bacon type.

The Meat Type

The meat type hog is primarily an American creation. It is found chiefly in the Corn Belt where corn is the principal feed.



Fig. 280. A Duroc sow of the "chuffy" type. Small, refined animals of this type dominated the American show ring from 1890 to 1910. (Courtesy Prof. A. L. Anderson, Iowa State College.)

Originally, breeders of hogs stressed immense size and
e and great fattening ability. This general type persisted
l the latter part of the nineteenth century. Beginning about
), breeders turned their attention to the development of early
urity, great refinement, and a very thick finish. In order to
in these desired qualities, animals were developed that were
ller in size, thick, compactly built, and very short of leg. In
Poland China breed, this fashionable fad was carried to the
eme. It finally culminated in the development of the "hot



Fig. 281. A Chester White boar pig of the "rangy" type. Long legged, loined, "cat hammed" animals of this type dominated the American ring from 1915 to 1925. (Courtesy, Breeders Chester White Record ciation.)

ds." Hogs of this "chuffy" type were notoriously lacking in
ificacy. They often farrowed twins and triplets; and when
were carried to weights in excess of 200 pounds, their gains
e very expensive. Small refined animals of this type dominated
show ring from about 1890 to 1910.

In order to secure increased utility qualities, breeders finally,
bout 1915, began the shift to the big-type strains. Before
, the craze swept across the nation, and again the pendulum
ng too far. Breeders demanded great size, growthiness, length
ody, and plenty of bone. The big-type animal was rangy in
ormation and slow in maturity. Many champions of the show
included as their attributes long legs, weak loins, and "cat

hams." One popular champion of the day was advertised as being "so tall that it makes him dizzy to look down." Inasmuch as this type failed most miserably in meeting the requirements of either the packer or the producer—being too slow to reach maturity and requiring a heavy weight in order to reach market finish—another shift in ideals became necessary.

Since about 1925, swine breeders have been striving to develop the medium or meat type. Although much real progress has been made, the present lack of uniformity within breeds bears evidence of the difficulties encountered in correcting such radical shifts. The best specimens of the meat type combine size, balance, and smoothness with feeding capacity and the ability to fatten during the growing period. Moreover, the present market trend is in the direction of a type that is less pronounced in lard character. In recognition of this change in consumer demand and in the consequent shift in type, most swine authorities now consider the term "meat type" as far more applicable than lard type. In holding to the meat type, the show ring has been stoutly augmented by swine type conferences.

The Bacon Type

Bacon type hogs are more common in those areas where the available feeds consist of dairy by-products, peas, barley, wheat, oats, rye, and root crops. As compared with corn, such feeds are not so fattening. Thus, instead of producing a great amount of lard, they build sufficient muscle for desirable bacon. The countries of Denmark, Canada, and Ireland have long been noted for the production of high-quality bacon. In the past, the surplus pork produced in these countries has found a ready market in England, largely selling as "Wiltshire sides." Two breeds of bacon type hogs are common: the Tamworth and the Yorkshire.

In emphasizing the importance of character of feeds as a factor influencing the production of the two types of hogs, it is not to be inferred that there is no hereditary difference. That is to say, when bacon type hogs are taken into the Corn Belt and fed largely on corn, they never entirely lose their bacon qualities. Likewise, lard type hogs still retain their identity when taken into a bacon-producing area where they are fed dairy by-products and small grains.

COMMON BREEDS OF MEAT AND ON TYPE HOGS IN THE UNITED STATES

The most common breeds of hogs in the United States, sed according to type, include the following:

Meat type breeds	Bacon type breeds
Berkshire	Landrace[1]
Chester White	Tamworth
Duroc	Yorkshire
Hampshire	
Hereford	
OIC	
Poland China	
Spotted Poland China	

With the exception of the Berkshire, Landrace, Tamworth Yorkshire, these breeds are strictly American creations. This teresting in view of the fact that none of our breeds of draft es and only one each of our better known breeds of sheep Columbias) and beef cattle (the Santa Gertrudis) were erican creations. With the exception of the Hereford breed some of the newer crossbred breeds of swine, the American ds came into being in the period from 1800 to 1880—an era h was characterized by the production of an abundance of for utilization by hogs and by consumer demand for fat, y cuts of pork. The European breeds did not seem to meet e requirements.

It must be remembered, however, that the American breeds wine were not developed without recourse to foreign stock. r to De Soto's importation, no hogs were found in the conti- . The offspring of De Soto's sturdy "razor-backs", together subsequent importations of European and Oriental hogs, ed as the foundation stock for the American breeds which wed. Out of these early-day multiple-colored and conglom- e types of swine, the swine producers of different areas of United States, through the tools of selection and controlled ngs, gradually molded uniform animals, later to be known reeds. It is to be noted, however, that these foundation ani- carried a variable genetic composition. This made them ble in the hands of man and accounted for the radical subse- nt shifts in swine types that have been observed within the breeds.

[1] Pure Landrace are not available commercially in the United States, re herein listed and discussed because of their importance in producing bred strains with the Landrace as one parent.

In the hands of skilled livestock men, swine are the most plastic of any species of farm animals. This is due to their early maturity, multiple rate of reproduction, and the short time between generations. A farmer who produces a total of one hundred spring-farrowed pigs yearly needs only sixteen gilts to raise a crop of the same size the following spring. There will be approximately fifty gilts from which he may select the sixteen brood sows needed. He has a wide choice of keeping the lardy and more early maturing gilts or of picking others of a meaty form. Continued selection each year with emphasis upon the same characteristics and the purchase of boars of the same type can completely alter the conformation of the hogs in a herd in the short period of four to five years.

RELATIVE POPULARITY OF BREEDS OF SWINE

Table 55 shows the 1949 and total registrations to date of the common breeds of hogs. Although trends are not shown in this table, it is noteworthy that the Hampshire, Yorkshire and inbred breeds are enjoying special popularity at this time.

TABLE 55

1949 AND TOTAL REGISTRATIONS OF SWINE IN UNITED STATES BREED ASSOCIATIONS[1]

Breed	1949 registrations	Total registrations
Duroc	116,149	2,722,414
Hampshire	58,510	835,385
Spotted Poland China	49,464	674,338
Poland China	30,127	2,238,764
Chester White[2]	29,546	760,713
Berkshire	21,775	655,265
OIC	20,323	287,519
Hereford[3]	9,634	75,045
Yorkshire	9,070	75,727
Inbred Livestock (Minnesota No. 1, Minnesota No. 2, and Hamprace)	4,380	14,551
Tamworth	2,572	99,000
Mulefoot	801	
Essex	320	15,085
Kentucky Red Berkshire	112	2,352

[1] *New England Homestead*, Springfield, Mass., Sept. 23, 1950, 123, 4

[2] Includes registrations in both the Chester White Swine Record Association and the Breeders' Chester White Record Association.

[3] Includes registrations in both the National Hereford and the Breeders' Hereford Associations, 1947 data.

MEAT BREEDS OF SWINE

Although there are many breed differences and most breed ciations are constantly extolling the virtues of their respec- breeds, it is perhaps fair to say that there is more difference in than between breeds from the standpoint of efficiency of uction and carcass quality. Without doubt, the future and ring popularity of each breed will depend upon how well it ls these two primary requisites.

Berkshire

The Berkshire is one of the oldest of the improved breeds of e and the only popular meat type breed in this country that t an American creation. The striking style and carriage of Berkshire has made it known as the aristocrat among the ls of swine.

IN AND NATIVE HOME:

The native home of the Berkshire is in south central Eng- principally in the counties of Berkshire and Wiltshire. The nglish hog, a descendant of the wild boar, served as founda- stock; and these early animals were improved by introducing ese, Siamese, and Neapolitan blood. In 1789, the Berkshire described as follows: reddish brown in color; with black , large drooping ears, short legs, fine bone, and the disposi- o fatten at an early age.

LY AMERICAN IMPORTATIONS:

The earliest importation of Berkshire hogs into the United s, of which there is authentic record, was made by John tnall, of New Jersey, in 1823. This importation was followed ose of Bagg and Wait, of Orange County, New York, in and A. B. Allen, of Buffalo, New York, in 1841.

Although there have been many constructive Berkshire ers in this country, certainly the name of N. H. Gentry, of ia, Missouri, is among the immortals. Few breeders either or abroad have achieved the success which was his. He was a "master breeder." The majority of the best Berkshires day trace to Gentry breeding, particularly to the great and otent boar, Longfellow.

KSHIRE CHARACTERISTICS:

The distinct peculiarity of the Berkshire breed is the short, rned nose. The face is dished, and the ears are erect but ed slightly forward. The color is black with six white points

—four white feet, some white in the face, and a white switch on the tail.

The conformation of the Berkshire may be described as excellent meat type. Fortunately, the "big-type craze" did not gain great momentum among Berkshire breeders. Thus, there seems to be pronounced uniformity within the breed at the present time.

The typical Berkshire is long bodied, with a long deep side; moderately wide across the back; smooth throughout; well bal-

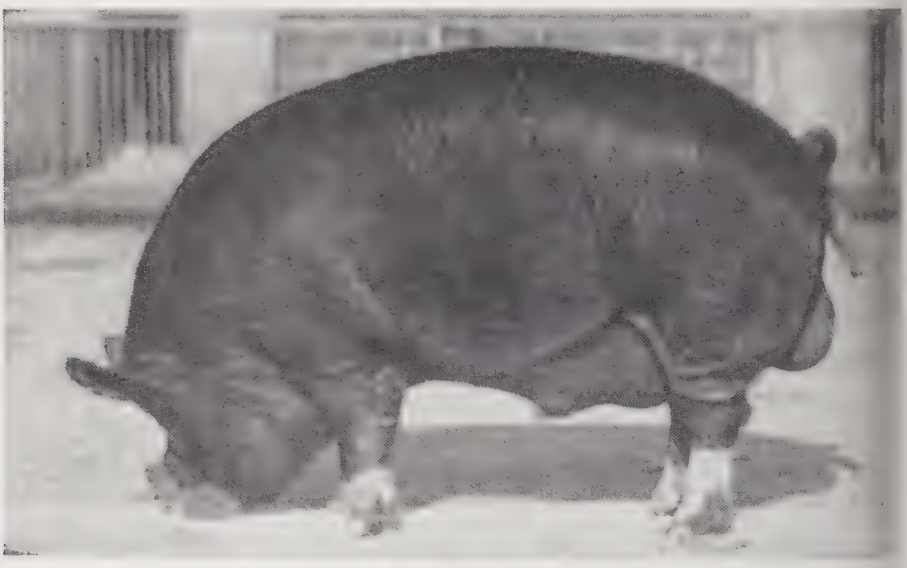


Fig. 282. Lynwood Guest, Grand Champion Berkshire boar, National Berkshire Show, 1948. Note the upturned nose, erect ears, and white points which are characteristic of the breed. (Courtesy, Lynnwood Farm, Carmel, Indiana.)

anced and medium in length of leg. The meat is exceptionally fine in quality, well streaked with lean, and has no heavy covering of fat. In the fat barrow and carcass contests of the country, the breed is second only to the Chester White.

There was a time when Berkshire sows were considered lacking in prolificacy. Judicious breeding and selection, however, have largely eliminated this criticism.

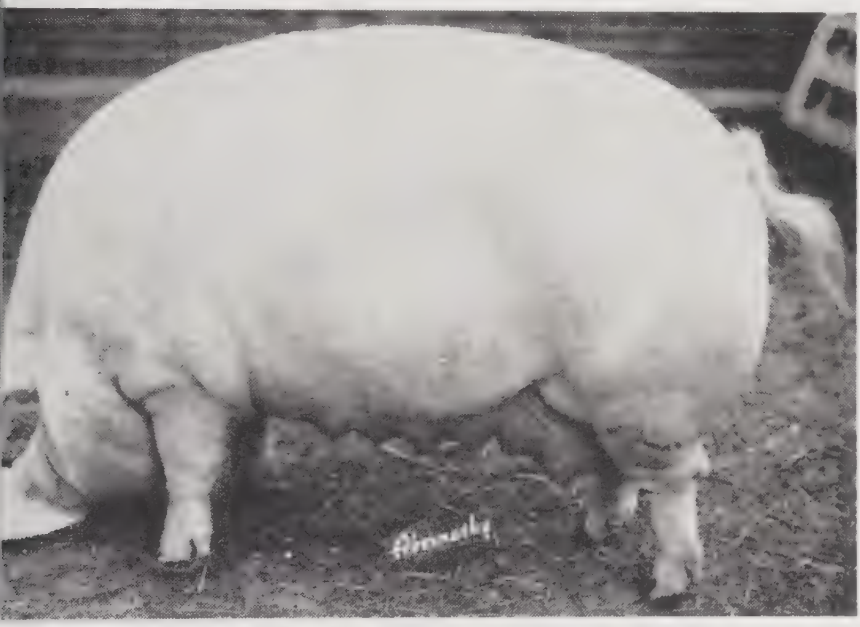
The Berkshire is not as large as most of the other breeds. However, because of its great length, depth, and balance, it is likely to be underestimated in weight. When in good show condition, mature boars weigh from 600 to 850 pounds and the sows from 450 to 650 pounds.

Chester White

The Chester White breed is very popular on the farms of orthern part of the United States, and barrows of this breed an enviable reputation in the fat classes of the Chicago national Livestock Show.

GIN AND NATIVE HOME:

The Chester White had its origin in the fertile agricultural on of southeastern Pennsylvania, principally in Chester and ware counties. Both of these counties border on Lancaster ty, one of the most noted agricultural and livestock coun- n the United States. The breed seems to have originated



ig. 283. Supreme Fancy 2nd, Grand Champion Chester White sow. s State Fair, 1947. Bred and exhibited by Harry A. Brett, Decatur, s. As the name indicates, the breed is white in color. (Courtesy, The r White Swine Record Association.)

in the nineteenth century from the amalgamation of several ls, most of which were white in color. The foundation stock led imported pigs of English Yorkshire, Lincolnshire, and nire breeding. In 1818, Captain James Jeffries of Chester ty imported a pair of white pigs from Bedfordshire, Eng- The boar in this importation was destined to exert a marked ng influence on the foundation stock of the Chester White . By 1848, the breed had reached such a degree of uniform- nd purity that it was named "Chester County White." The

word "county" was soon dropped, and the present name became established.

CHESTER WHITE CHARACTERISTICS:

As the name indicates, the breed is white in color. Although small bluish spots, called freckles, are sometimes found on the skin, such spots are to be discriminated against. The light color of the breed has caused it to be subject to sun scald in the South.

In general, type changes within the breed have followed those of the Poland China and the Duroc, although they have been less radical in nature. No doubt, some Yorkshire blood was infused into certain herds during the "big-type craze." Perhaps this blood has brought real improvement and benefit to the breed.

Chester White sows are very prolific and are exceptional mothers. The pigs are good feeders and grazers; they mature early; and the finished barrows are very popular on the market.

The Duroc

The Duroc is the leading breed of swine in America, registering twice as many purebreds annually as any other breed of swine.

ORIGIN AND NATIVE HOME:

The Duroc breed of swine originated in the northeastern section of the United States. Although several different elements composed the foundation stock, it is reasonably certain that the Durocs, of New York, and the Jersey Reds, of New Jersey, contributed most to the ancestry.

The Jersey Reds were large, coarse, prolific red hogs that were bred in New Jersey early in the nineteenth century. The Durocs were smaller in size, more compact, and possessed great refinement. The red hogs of uncertain origin, which were found in New York, were named after the famous stallion, Duroc, a noted horse of that day. Beginning about 1860, these two strains of red hogs were systematically blended together, and thus there was formed the breed that is known at the present time as the Duroc.

DUROC CHARACTERISTICS:

The Duroc is red in color, with the shades varying from light to dark. Although a medium cherry red is preferred by the majority of breeders, there is no particular discrimination against lighter or darker shades so long as they are not too extreme.

During the big-type era, the Duroc also had its changes in type. The show ring was dominated by tall, rangy individuals

als possessing narrow loins, light hams, shallow bodies, and maturity. Although some lack of uniformity still exists n the breed as a result of this radical shift, today the best sentatives are of the most approved meat type. The great larity of the breed may be attributed to the valuable combi- n of size, feeding capacity, prolificacy, and hardiness. There ow twice as many purebred, registered Durocs as any other l.

In show condition, aged Duroc boars weigh from 750 to 1,100 ds and mature sows from 600 to 850 pounds.



ig. 284. Tiptop Princess 4th, Grand Champion Duroc sow of the 1948 ska State Fair. Owned by George Carlson & Son, Saronville, Nebraska. Duroc is red in color, with the shades varying from light to dark. tesy, United Duroc Record Association.)

Hampshire

The Hampshire is one of the youngest breeds of swine, but ise in popularity has been rapid. It is widely distributed ughout the Corn Belt and the South.

GIN AND NATIVE HOME:

The Hampshire breed of swine originated in Boone County, ucky, just across the Ohio River from Cincinnati. The foun- n stock consisted of fifteen head of belted hogs, generally n as "Thin Rinds" and "Ring Middles." This original herd purchased in Pennsylvania in 1835 by Major Joel Garnett,

who had the animals driven to Pittsburgh and then sent by boat to Kentucky. Years later, in 1893, six Boone County (Kentucky) farmers organized the "Thin Rind Association," which, in 1904, became the Hampshire Swine Association.

The origin of the foundation herd purchased by Major Garnett is clouded in obscurity. However, belted hogs were reported in Massachusetts and New York between 1820 and 1830. Moreover, the Essex and Wessex Saddleback breeds of England possess the same color pattern as the present-day Hampshire.



Fig. 285. Blender Bound, 1947 and 1948 All American Hampshire boa Owned by Kelly Farms, Deer Creek, Illinois. The most striking chara teristic of the Hampshire breed is the white belt around the shoulders an body, including the front legs. (Courtesy, American Hampshire Herdsman

HAMPSHIRE CHARACTERISTICS:

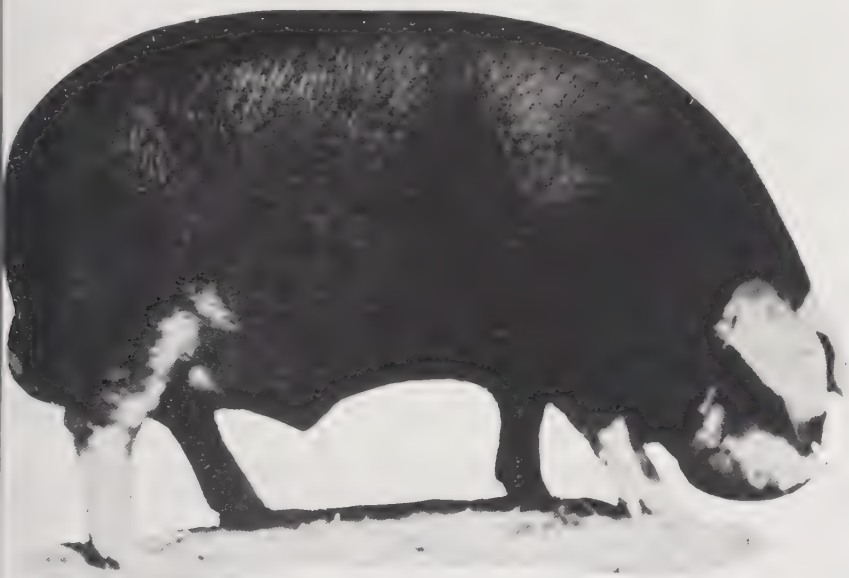
The most striking characteristic of the Hampshire is th white belt around the shoulders and body, including the fro legs. The black color with the white belt constitutes a distincti trademark; breed enthusiasts refer to it as the "million doll trademark."

Hampshire breeders have always stressed great quality a smoothness. The jowl is trim and light, the head refined, the ea erect, the shoulders smooth and well set, and the back w arched. An effort is now being made to secure more length body and greater fullness of hams. In general, the breed has n been subjected to radical type fads. The trimness and freed

excess lardiness gives promise of a bright future for the pshire. Animals of this breed are active, and the sows have utation of raising a high percentage of the pigs farrowed. As a rule, Hampshires are not so heavy as the other breeds. ow condition, mature boars weigh from 700 to 900 pounds nature sows in similar condition from 550 to 750 pounds.

Hereford

The Hereford is one of the newer and less widely distributed s of swine. Among many swine growers, it has enjoyed a al attraction because the color markings emulate those of ford cattle.



ig. 286. Fashion Model, Reserve Champion Hereford Boar of the 1946 nal Hereford Show. Owned and exhibited by Chas. Booz, Portis, Kan- he color markings are similar to those of Hereford cattle. (Courtesy, nal Hereford Hog Record Association.)

GIN AND NATIVE HOME:

The Hereford breed of hogs was founded by R. U. Webber, aPlata, Missouri. He conceived the idea of producing a white- d hog with a cherry-red body color that would resemble the kings of Hereford cattle. The foundation stock included Ches- Whites, O.I.C.'s, Durocs, and pigs of unknown origin. By eeding and selection, the breed was further developed over riod of twenty years. In 1934, the National Hereford Hog ciation was organized.

HEREFORD CHARACTERISTICS:

The most distinctive characteristic of the Hereford breed of hogs is their color marking, which is similar to that of Hereford cattle. In order to be eligible for registry, animals must be at least two-thirds red in color, either light or dark, and must have white faces; and white must appear on at least two feet and extend at least an inch above the hoof. The ideal colored Hereford has a white head and ears, four white feet, white switch, and white markings on the underline.

In size, the Hereford is smaller than the other breeds of swine. At the present time, many specimens of the breed are considered too lardy, heavy shouldered, and rough; but great improvement is being made through selection.

The OIC

Although the OIC (commonly but now incorrectly referred to as Ohio Improved Chester) and Chester White breeds stemmed from the same parent stock in Chester County, Pennsylvania, they are now distinct and separate breeds. Today, their chief resemblance is in color only, both being white.

ORIGIN AND NATIVE HOME:

The OIC was originated by L. B. Silver of Salem, Ohio. While traveling through the eastern states in 1865, for the purpose of studying the pure breeds of swine, he selected the four-

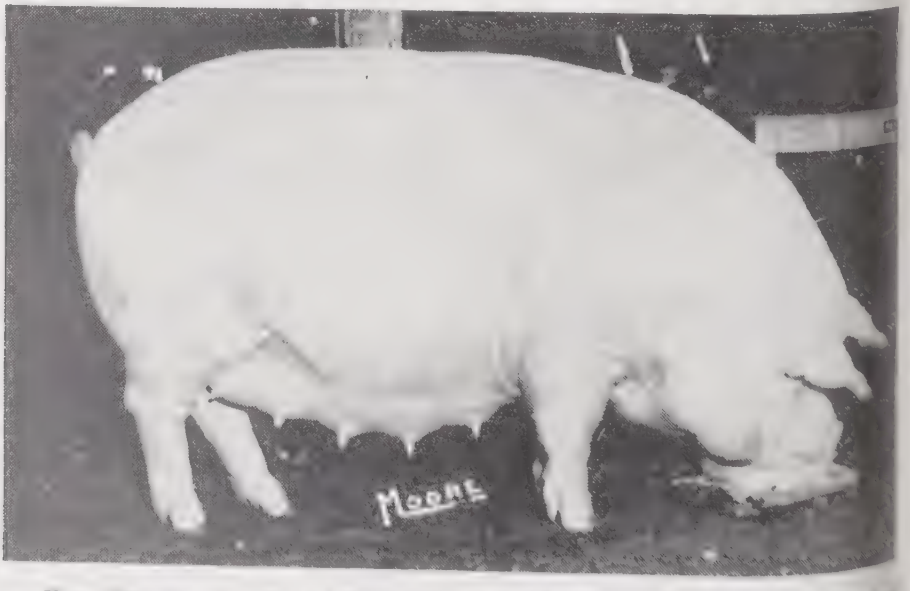


Fig. 287. Hoosier Pearl DII, OIC sow. (Courtesy, OIC Swine Breeders Association, Inc.)

n stock in Chester County, Pennsylvania. In subsequent s, Mr. Silver and his son, Carl, are reputed to have wrought improvement in their herd, developing white hogs that larger and more prolific than the common run of Chester es of the day. Although Mr. Silver had long maintained te facilities for recording his hogs, he was instrumental in nizing the OIC Swine Breeders Association in 1897.

After the death of Mr. Silver, the OIC suffered from lack of otion. In recent years, however, it has gained in popularity. 49, the breed ranked seventh in total registrations of U. S. ds of swine, closely approaching Berkshires in numbers.

CHARACTERISTICS:

The OIC breed escaped the big type craze, in vogue in most e breeds of swine from 1915 to 1925. They clung to the y type. Even today, many representatives of the OIC breed f the chuffy rather than the intermediate type, although essive breeders are making strides in rectifying this situa-

Poland China

No other breed of swine has been subjected to such radical s in type as the Poland China. Likewise, no other breed has g from such heights of popularity or fallen so low in dis-e.

GIN AND NATIVE HOME:

The Poland China breed of swine originated in southwestern in the fertile area known as the Miami Valley, particularly arren and Butler Counties. In the early part of the nine-h century, the Miami Valley was the richest corn-producing on of the United States. Moreover, prior to the Civil War, nnati was the pork-packing metropolis of America. Thus conditions were ideal for the development of a new breed gs.

The common stock kept by the early settlers of the Miami y were described as of mixed color, breeding, and type. The dation animals were crossed with the Russian and Byfield that were introduced into the valley early in the nineteenth ry. In 1816, the Shaker Society, a religious sect, introduced Big China breed. This breeding and improvement gave rise e so-called "Warren County" hog, which gained considerable inence as a result of its huge size and great fattening ability. r, hogs of Berkshire and Irish Grazier breeding were intro-

duced into the area and were crossed with the "Warren County" hogs. This improved the quality and refinement of the stock and resulted in earlier maturity. It is generally agreed that no outside blood was brought into the Miami Valley after about 1845.

The name, Poland China, was established in 1872 by the National Swine Breeders in convention at Indianapolis, Indiana. In view of the fact that it seems to be definitely established that no breed known as "Poland" hogs was ever used as foundation stock, it is of interest to know how the name, Poland China, was selected. Asher, a prominent Polish farmer in the Valley, was supposedly responsible for the word "Poland." As China hogs had been introduced by the Shaker Society, the name of "Poland China" was adopted.



Fig. 288. Masterpiece, Grand Champion Poland China Boar of the 194 Illinois and Wisconsin fairs, shown by Oscar W. Anderson, Leland, Illinois Poland Chinas are black in color with six white points. (Courtesy, M. M Meneough, Grimes, Iowa.)

POLAND CHINA CHARACTERISTICS:

Modern Poland Chinas are black in color with six white points—the feet, face, and tip of tail—but prior to 1872, the were generally mixed black and white and spotted. Absence o one or two of the six white points is of small concern, and a sma white spot on the body is not seriously criticized.

Until the latter part of the nineteenth century, Poland Chin hogs were noted for their immense size and scale. Beginning about 1890, breeders turned their attention to the developmen

reater refinement, earlier maturity, and smaller size. This ionable fad finally culminated in the development of the "hot ls," an extremely small, compact, short-legged type which nated the show ring from 1900 to 1910.

Finally, in order to secure increased utility qualities, breed- began the shift to the big-type strains. The craze swept ss the nation, and again the pendulum swung too far. How- since 1925, the efforts of breeders have been toward de- ment of the more conservative meat type.

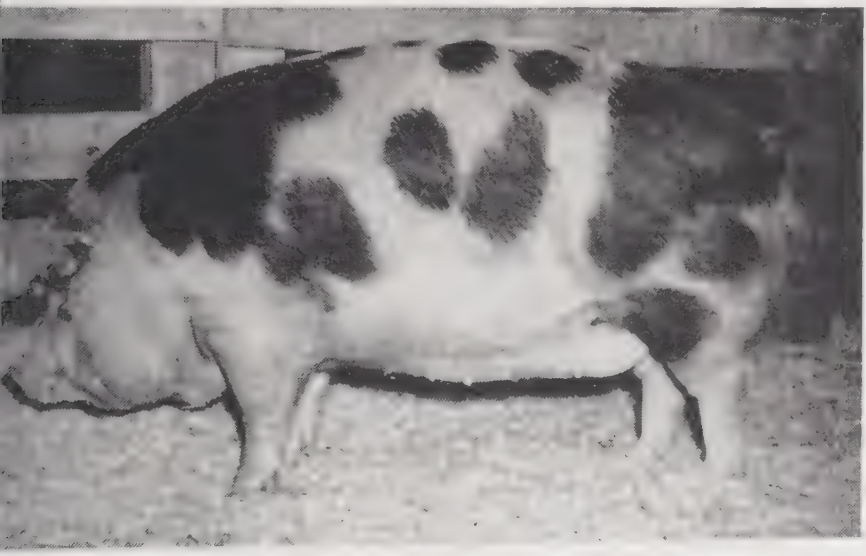
Mature Poland China boars in show condition weigh from o 1,000 pounds and mature sows from 650 to 900 pounds.

Spotted Poland China

At the present time, the Spotted Poland China ranks ahead e Poland China in popularity and number of animals reg- ed annually. This rapid rise in numbers of the "Spots" is y attributed to the success of breeders in preserving the y value of the old Spotted Polands while making certain im- ements in the breed.

GIN AND NATIVE HOME:

The Spotted Poland China was developed in the north central of the United States, principally in the state of Indiana. as been indicated, the foundation stock of the Miami Valley d Chinas was frequently of a black and white spotted color.



ig. 289. A first prize Spotted Poland China gilt of the 1948 National d Poland China Show and Sale. The most desired breed color is d black and white, about 50 per cent of each. (Courtesy, The Na- Spotted Poland China Record.)

Moreover, they had a reputation for size, ruggedness, bone, and prolificacy. During the era of the "hot bloods," many breeders forsook the Poland China breed and attempted to revive the utility qualities of the original spotted hogs of the Miami Valley. Thus, the Spotted Poland China was established. In addition to utilizing selected strains of the Poland China, breeders introduced, in 1914, the blood of the Gloucester Spotted hog of England. Although the Spotted Poland China breed had its official beginning with the organization of record associations in 1914, liberal infusion of big-type Poland China blood was continued until ten years later.

SPOTTED POLAND CHINA CHARACTERISTICS:

At the present time, there is no great difference between the most approved type of Poland China and the Spotted Poland China. The former has a little more size, but in general the conformation is much alike.

The most desired color in the Spotted Poland China is spotted black and white—50 per cent of each. In order to be eligible for registry, animals must have not less than 20 per cent nor more than 80 per cent of white on the body.

Boars in show condition weigh from 750 to 1,000 pounds and sows from 600 to 800 pounds.

THE BACON BREEDS OF SWINE

All bacon type breeds of swine are now enjoying a rapid rise in popularity. This is primarily due to the desire to avoid surplus lard production.

The Landrace

As was originally true of Spain with its Merino sheep, Denmark holds a monopoly on the Landrace breed of swine. Although purebred Landrace hogs have been shipped to the United States and Canada, by government agreement they cannot be released as purebreds, their use being restricted to crossbreeding.

The Landrace, however, is becoming of increasing importance in this country, because of the many new strains of hogs that are based on a cross-bred foundation with this breed as one of the parents.

ORIGIN AND NATIVE HOME:

The Landrace breed of hogs is native to Denmark, where it has been bred and fed to produce the highest quality bacon in the world. With the aid of government testing stations, the

ace breed has long been selected for improved bacon carcass y and efficiency of pork production. In addition to improved ng, the feeds common to Denmark—small grains and dairy oducts—are also conducive to the production of high-quality . For many years, the chief outlet for the surplus pork of ark has been the London market, where it is sold primarily form of Wiltshire sides.

RACE CHARACTERISTICS:

he Landrace breed is white in color, although black skin or "freckles" are rather common. The breed is character- y its long, deep side; square ham; relatively short legs;



g. 290. A prize winning Landrace sow in Denmark. Note the long, de; relatively short legs; heavy, lop ears; and large row of teats. esy, Danish Embassy.)

owl; heavy lop ears: sometimes low back; and frequently pasterns. The carcass is more lean than that of the meat ogs of American origin, and there is less back fat and lard. reed is noted for prolificacy and for efficiency of feed utili-

t the present time, the U. S. Department of Agriculture everal agricultural colleges are using Landrace swine in reeding work. The most widely known line in which the ace breed has served as one of the foundation parents is the sota No. 1. This line was produced by the University nesota from a cross between Landrace boars and Tam- sows. (The breeding work was begun in 1937). At the

present time, The State College of Washington is in the process of developing a very promising but unnamed line based on a Landrace X Chester White foundation. Montana State College and the U. S. D. A. have jointly developed the Hamprace, a strain derived from a Landrace-Hampshire (black Hampshires) foundation.

The Tamworth

The Tamworth is one of the oldest and probably one of the purest of all breeds of hogs. It is also recognized as the most extreme bacon type of any breed.

ORIGIN AND NATIVE HOME:

The native home of the Tamworth is in central England in the counties of Stafford, Leicester, Warwick, and Northampton. The breed derives its name from the town of Tamworth, which is located on the river Thames.

Although little is known concerning the early history and development of the breed, it is probably safe to assume that it is descended from the Old English hog which resulted from domestication of the wild boar.

There is no evidence to indicate that any breed improvement was attempted through crossing with other breeds. On the other hand, there is record of pure breeding and careful selection dating back more than one hundred years.

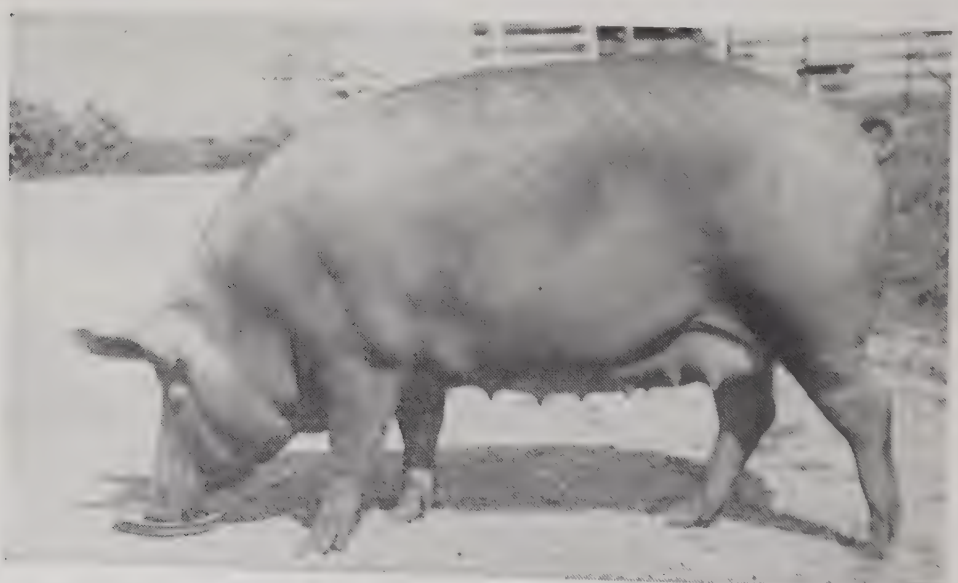


Fig. 291. Gormley May 6A, Tamworth sow owned by R. H. Waltz & Sons, Hagerstown, Indiana. Note the extreme bacon type. (Courtesy, Tamworth Swine Association.)

RLY AMERICAN IMPORTATIONS:

The earliest importation of Tamworths into the United es, of which there is authentic record, was made by Thomas nett, of Rossville, Illinois, in 1882. Numerous importations made to Canada soon thereafter. Owing to its extreme bacon , the breed never became popular in this country. With lard ng returned to the status of a "drug upon the market" fol- g World War II, an increasing number of swine producers becoming interested in Tamworths.

WORTH CHARACTERISTICS:

The color of the breed is red, varying from light to dark. conformation may be described as that of extreme bacon The individuals are rather long-legged; with long, smooth , and strong backs. The head is strikingly long and narrow, a long snout and fairly large ears that are carried somewhat . The Tamworth carcass produces bacon of the finest quality. sows are prolific and careful mothers, and the pigs are excel- foragers.

Mature boars weigh from 700 to 900 pounds and mature from 550 to 700 pounds.

Yorkshire

In its native home, England, the Yorkshire breed is known e Large White. Since World War II, there has been a pro- ced interest in raising more Yorkshire hogs in the United s.

IN AND NATIVE HOME:

The Yorkshire is a popular English bacon breed which had rigin nearly a century ago in Yorkshire and neighboring ies in northern England. The foundation stock consisted of , coarse white hogs with black or bluish spots on the skin. were direct descendants of the Old English hogs. Subse- improvement in this stock was effected through the infu- of blood of the Leicester pig, a creation of Robert Bakewell. ver, the Yorkshire breed was not crossed with foreign blood y great extent. Rather, its improvement is a tribute to care- reeding and judicious selection.

LY AMERICAN IMPORTATIONS:

Although Yorkshires were probably first brought to the d States early in the nineteenth century, representatives modern type were first introduced by Wilcox and Liggett,

of Minnesota, in 1893. A great many importations were made in Canada at an early date, and the breed has always enjoyed position of prominence in that country.

YORKSHIRE CHARACTERISTICS:

Yorkshires should be entirely white in color. Although blac pigment spots called "freckles" do not constitute a defect, the are frowned upon by breeders.

Yorkshire sows are noted as good mothers. They not onl farrow and raise large litters, but they are great milkers. Th pigs are excellent foragers and compare favorably with those o any other breed in economy of gains.

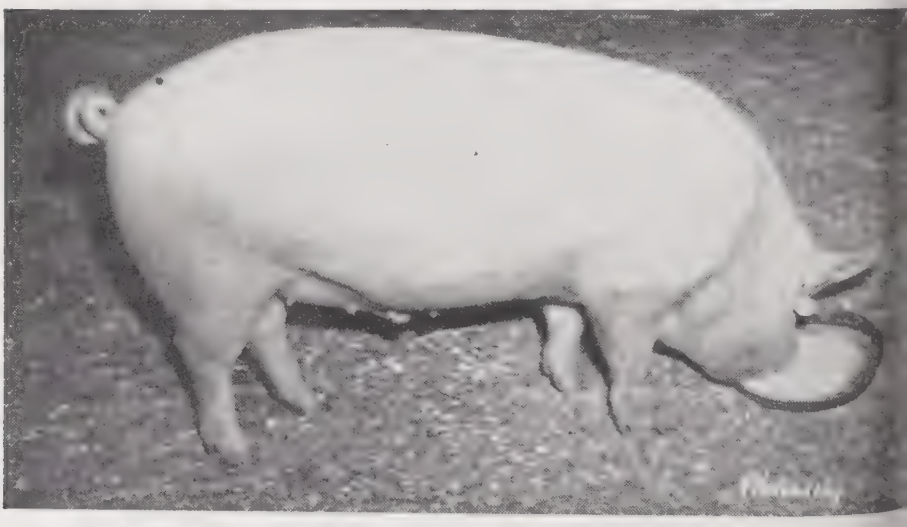


Fig. 292. Grand Champion Yorkshire barrow of the 1947 Chicago Inte national, shown by Curtiss Candy Company. Note the long, deep side. (Cou tesy, Curtiss Candy Co. Farm, Cary, Illinois.)

Yorkshire hogs are smooth; the body is long and deep, wit an especially long, deep side; the loins are large; but sometime the hams lack depth and plumpness. Slaughter animals yield high dressing percentage and produce bacon of the finest quality The present surplus of lard in this country is causing breeder and promoters of the meat breeds to change their ideals in ty more in keeping with that of the most approved Yorkshire Moreover, Yorkshires are becoming very popular, even in t Corn Belt.

LESS WIDELY DISTRIBUTED BREEDS

In addition to the more widely distributed swine breeds th have already been discussed, some of the new and less numero

ds of importance in different sections of the United States isted in Table 56.

TABLE 56

LESS WIDELY DISTRIBUTED BREEDS OF SWINE

eed	Color	Place of origin
ire	White	United States (New York)
	Black body with white belt and feet	England
race	Black	United States (Montana)
cky Red kshire	Red	United States (Kentucky)
Black	Black	England
sota No. 1	Red	United States (Minnesota)
sota No. 2	Black and white	United States (Minnesota)
oot	Black	Indefinite; animals of this type known for centuries in Sweden, Denmark, Holland, South Africa, Mexico, and South America.
k	Yellowish-white	England
ia	White	United States (Indiana and New York)



ig. 293. A Minnesota No. 1 sow. Note the bacon type. (Courtesy, Dr. Winters, University of Minnesota.)

CHAPTER XXIX

ESTABLISHING THE HERD; SELECTING AND JUDGING SWINE

The problems encountered and the principles employed i establishing the swine herd and in selecting and judging hogs ar very similar to those outlined for beef cattle and sheep. In gen eral, however, one can establish a swine herd at a lower cost an more quickly than is possible with other classes of farm animals Also—and this is a sad commentary—hog markets are less dis criminating than cattle or sheep markets, with the result tha the average commercial producer gives far less attention t becoming proficient in selecting and judging swine.

FACTORS TO CONSIDER IN ESTABLISHING THE HERD

At the outset, it should be recognized that the vast majorit of the four million swine producers of this nation keep hog simply because they expect them to be profitable. That hogs hav usually lived up to this expectation is attested by their undis puted claim to the title of "the mortgage lifter." For maximu profit and satisfaction, in establishing the herd the individua swine producer must give consideration to the type, breedin and individual merit of each foundation animal, and to the si of the herd.

Type: Meat vs. Bacon; and Large, Medium, or Small

With reference to hogs, the word "type" is used in a du capacity: (1) to denote whether breeds are of meat (or lard type or bacon type and (2) to denote the difference in form an general conformation within a breed on the basis of large, me dium, or small type.

The difference in the general conformation and form betwee the modern meat and bacon types is less pronounced than formerly, primarily because of a shift of ideals within the meat ty breeds. With lard becoming a "drug on the market," often sell for less per pound than the price of fat hogs on foot, the breede of the meat type breeds are stressing the maximum cut-out val of primal cuts together with a minimum of lard. Thus the mo desirable specimens of the so-called meat breeds now more close

roach the bacon type breeds. In addition to this shift, the on type breeds and certain crossbreds (with one or both ents of bacon type) have found increasing favor in this coun- in recent years, even invading the Corn Belt. Perhaps there ittle difference in efficiency of production between the best imens of the meat and bacon type breeds. From a profit dpoint, therefore, any differences that may accrue are chiefly result of price differentials that may exist on the market. In eral, to date, central livestock markets have shown little nation to pay any marked premium for a quality product. nay be concluded, therefore, that under present conditions, e is not likely to be any difference between meat and bacon breeds from the standpoint of efficiency of production and ket returns.

As approximately 95 per cent of the market hogs of the ent day are of the so-called meat type breeds, further discus- relative to possible variations of types within these breeds be appropriate; for not all of these animals within breeds of the true meat type. Over the years, most of these breeds run the gauntlet in types, producing animals of the chuffy, y, and medium types. It is evident even today that these ds possess the necessary store of genes through which such in types may be made by breeding and selection. Even so, pork producers prefer the medium or intermediate type to r the "chuffy" or "rangy" types. Chuffy type animals lack olificacy and rapidity of gains, whereas the rangy hog must arried to too heavy a weight in order to reach market finish. packer and consumer object to the chuffy animals because eir excess lardiness and to the rangy ones because of their cuts that lack plumpness. It may be concluded, therefore, most successful swine producers of the present day favor dium type or meat type hog.

breds, Grades, or Crossbreds

Generally speaking, only the experienced breeder should rtake the production of purebreds with the intention of tually furnishing foundation or replacement stock to other ored breeders or purebred boars to the commercial producer. ever, in many cases the spread in price between purebred grade gilts is so small as to warrant the purchase of the er, even for commercial production. In any event, the use of rebred boar is always to be advocated.

Crossbreeding of swine is fully discussed in Chapter XX
It is sufficient to say that this type of breeding program is mo
widely used in the production of hogs than with any other cla
of livestock, and under certain conditions it may be advantageou

Selection of the Breed

No one breed of hogs can be said to excel others in all point
of swine production and for all conditions. It is true, howeve
that particular breed characteristics may result in a certain bree
being better adapted to given conditions; for example, hogs
light color are subject to sun scald in the deep South. Usuall
however, there is more difference among individuals within th
same breed than between the different breeds; this applies bot
to type and efficiency of production. In the end, therefore, th
selection of a particular breed is most often a matter of persona
preference, and usually the breed that the individual produce
likes is the one with which he will have the greatest degree
success. Where no definite preference exists, however, it is we
to choose the breed that is most popular in the community. Thi
consideration allows for greater latitude in the choice of founda
tion stock and makes less difficult the problem of securing her
boars. The producer should also give some thought to the loca
market demands and initial costs.

Size of Herd

Hogs multiply more rapidly than any other class of far
animals. They also breed at an early age, produce twice eac
year, and bear litters. It does not take long, therefore, to ge
into the hog business.

The eventual size of the herd is best determined by the fo
lowing factors: (1) size of farm, (2) available grains and pas
tures, (3) kind and amount of labor, (4) the disease and parasi
situation, (5) the probable market, and (6) comparative profi
from hogs and other types of enterprises.

Uniformity

Uniformity of type and ancestry gives assurance of
production of high-quality pigs that are alike and true to ty
This applies both to the purebred and the grade herd. Unifo
offspring sell at a premium at any age, whether they are s
as purebreds for foundation stock, as feeder pigs, or as fat ho
With a uniform group of sows, it is also possible to make a m
intelligent selection of the herd boar.

lth

Breeding animals that are in a thrifty, vigorous condition that have been raised under a system of swine sanitation breeders who have exercised care in the control of diseases parasites) should have a decided preference. Tests should be le to make certain of freedom from swine brucellosis or con- ous abortion. In fact, all purchases should be made subject he animals being free from contagious diseases.

In establishing the herd, the beginner may well purchase a bred gilts that are well grown, uniform in type, and of good estry and that have been mated to a "proved" sire. Although risk is involved in the purchase of tried sows, the cost is ly to be greater in relation to the ultimate value of the sows he market.

Then, too, with limited capital, it may be necessary to con- r the purchase of a younger boar. Usually a wider selection fforded with this procedure, and in addition the younger ani- has a longer life of usefulness ahead.

e

The beginner should always start in a conservative way. rever, this should never be cause for the purchase of poor viduals—animals that are high at any price.

LECTION AND ITS BASES

Generally, the selection of foundation hogs is made on the s of one or more of the following considerations: (1) type or viduality, (2) pedigree, (3) show-ring winnings, or (4) pro- ion testing.

ction Based On Type or Individuality

In addition to choosing between (1) meat type and bacon animals and (2) rangy-, medium-, and chuffy-type indi- als, selection based on type or individuality implies the selec- of those animals that most closely approach the ideal or dard of perfection and the culling out of those that fall short ese standards.

ction Based On Pedigree

In the selection of breeding animals, the pedigree is a record he individual's heredity or inheritance. If the ancestry is l, it lends confidence in projecting how well young animals breed. It is to be emphasized, however, that mere names

and registration numbers are meaningless. A pedigree may b considered as desirable only when the ancestors close up in th lineage—the parents and grandparents—were superior individu als and outstanding producers. Too often, purebred hog breeder are prone to play up one or two outstanding animals back in th third or fourth generations. If pedigree selection is to be of an help, one must be familiar with the individual animals liste therein.

The boar should always be purebred, which means that h is of known ancestry. This alone is not enough, for he shoul also be a good representative of the breed selected; and his pedi gree should contain an impressive list of noted animals. Likewise it is important that the sows be of good ancestry, regardless o whether they are purebreds, grades, or crossbreds. Such ancestry and breeding gives more assurance of the production of high quality pigs that are uniform and true to type.

Selection Based On Show-Ring Winnings

Swine producers have long looked favorably upon using show-ring winnings as a basis of selection. Purebred breeders have been quick to recognize this appeal and to extol their cham pions through advertising. In most instances, the selection o foundation or replacement hogs on the basis of show-ring win nings and standards has been for the good. Certainly on many occasions, purebred and commercial breeders alike have come t regret selections based on show-ring winnings. This was espe cially true during the eras when the chuffy or rangy types were sweeping shows from one end of the country to the other. This would indicate that some scrutiny should be given to the type o animals winning in the show, especially to ascertain whether such animals are of a type that are efficient from the standpoint of the producer and whether, over a period of years, they wi command a premium on a discriminating market.

Perhaps the principal value of selections based on show-ring winnings lies in the fact that shows direct the attention of th amateur to those types and strains of hogs that at the moment are meeting with the approval of the better breeders and judges

Selection Based On Production Testing

No criterion that can be used in selecting an animal is s accurate or important as past performance. It is recommended

refore, that one purchase tried sows and a proved herd boar n such animals of the right kind can be secured at reasonable es. Unfortunately, breeding animals of known merit are not lly available at a figure that a beginner can afford to pay. etimes, however, established breeders make the error of ificing brood sows of proved performance in favor of younger s or find it necessary to sell proved boars because they can nger be used in the breeding program. Animals of this kind titute one of the soundest purchases that a young breeder make.

Several of the purebred swine registry associations have loped register-of-merit testing programs. Although these rams are not perfect, they do represent a progressive step he right direction. Without doubt, the swine producers of future will make increasing use of production records as sis for selection. Both purebred and commercial hog men pay more and more attention to such records. (Production rds in swine are discussed in Chapter XXX).

In selecting swine on the basis of production records, it is gnized that the amount of emphasis placed on each of the s should vary from herd to herd and area to area. For nple, where high-quality bacon is being produced for a dis- inating market, it is logical that greater emphasis should be ed on body type or, better yet, that carcasses of near relatives tudied.

RD IMPROVEMENT THROUGH SELECTION

Constructive breeders are those who effect improvement ugh breeding and selection, and this applies to both purebred commercial producers. Such selection must be based on pro- ion factors of economic importance and market price as rmined by carcass quality on a discriminating market.

GING SWINE

As previously indicated, the spread in market classes and es of swine has, to date, offered little incentive to commercial e producers to become proficient in judging. It is to the ever- ng credit of the purebred swine breeders, however, that they been very progressive in this respect. The swine type con- nces sponsored by the various breed associations have made ique contribution. Through bolstering live-animal work with eral amount of carcass data, these contests have soundly set ions for both the producer and the packer.

Parts of a Hog

Most successful hog men, including both purebred and commercial producers, know the parts of a hog. In addition, they are aware of the possible merits of maximum development of these different parts from the standpoint of economical production and market value. (Figure 294 shows the parts of a hog.)

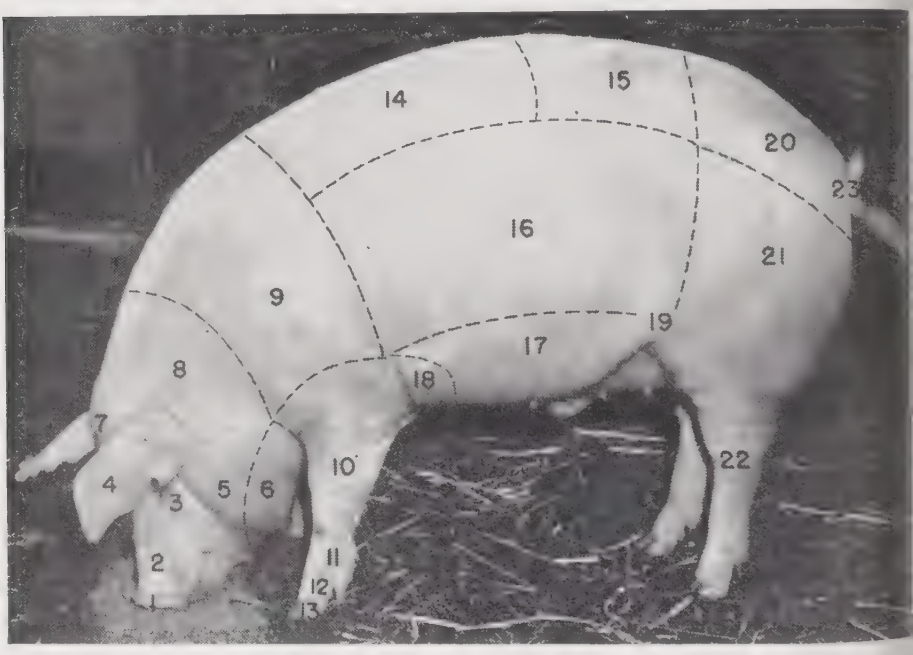


Fig. 294. Parts of a hog. The first step in preparation for judging hogs consists in mastering the language that describes and locates the different parts of the animal. The Chester White barrow shown above was Grand Champion over all breeds at the 1947 Grand National Livestock Exposition, San Francisco. Bred and exhibited by The State College of Washington.

1. Snout	7. Poll	13. Toes	19. Rear flank
2. Face	8. Neck	14. Back	20. Rump
3. Eye	9. Shoulder	15. Loin	21. Ham
4. Ear	10. Fore leg	16. Side	22. Rear leg
5. Cheek	11. Dew claw	17. Belly	23. Tail
6. Jowl	12. Pastern	18. Fore flank	

Ideal Type and Conformation

The next requisite in judging or selection is to have clear in mind a standard or ideal. Presumably, this ideal should be based on a combination of (1) the efficient performance of the animal from the standpoint of the producer and (2) the desirable carcass characteristics of the market animals as determined by the consumer.

The most approved meat type breeding animals combine size, smoothness and quality, and the offspring possess the ability

atten during the growing period without producing an excess- amount of lard. The head and neck should be trim and neat; back well arched and of ample width; the sides long, deep, smooth; and the hams well developed and deep. The legs uld be of medium length, straight, true, and squarely set; the erns should be short and strong; and the bone should be le and show plenty of quality. With this splendid meat type, e should be style, balance, and symmetry and an abundance uality and smoothness.

The most approved bacon type breeding hogs differ from above description of meat type animals chiefly in that greater

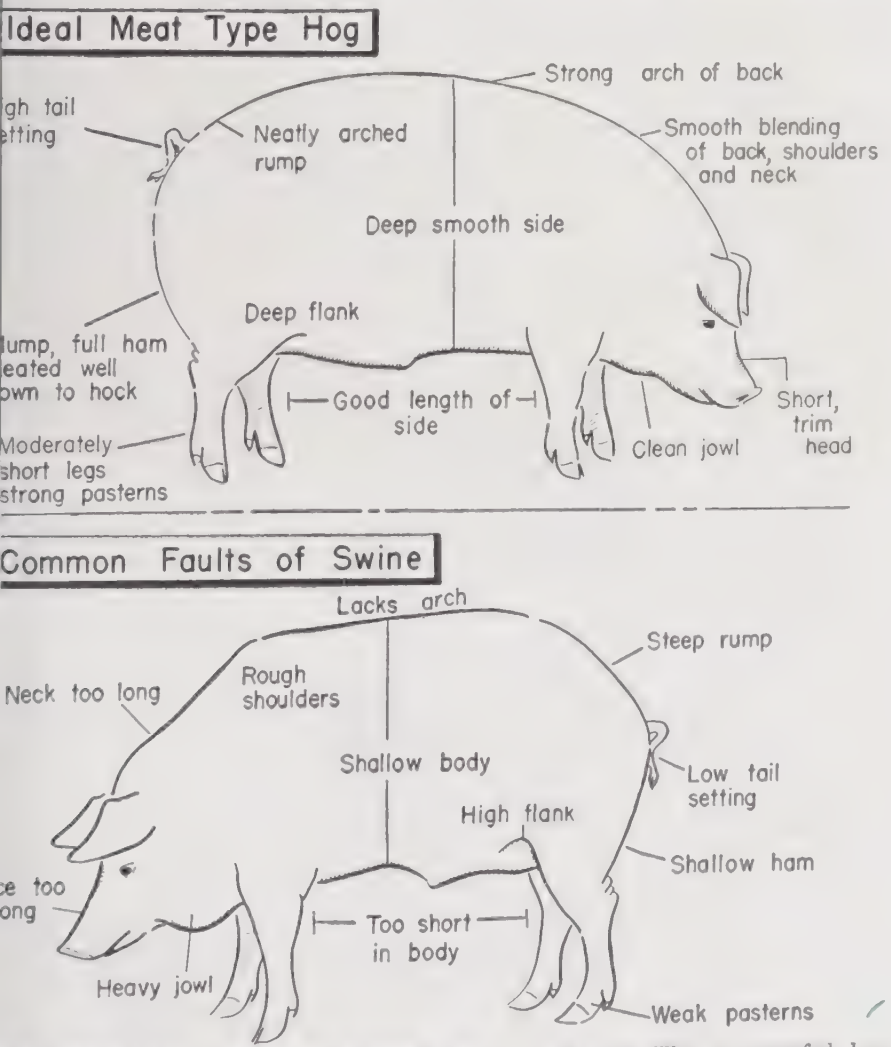


Fig. 295. Ideal meat type versus common faults. The successful hog ge must know what he is looking for and be able to recognize and ap- se both the good points and the common faults. (Drawing by R. F. John-)

emphasis is placed on length of side and the maximum develop ment of the primal cuts with the minimum of lard. Also, bacon type hogs generally have less width over the back and a square type of ham, and they show more trimness throughout.

With both meat and bacon type animals, the brood sow should show great femininity and breediness; and the udder should be well developed, carrying from ten to twelve teats. The herd boar should show great masculinity as indicated by strength and character in the head, a somewhat crested neck, well developed but smooth shoulders, a general ruggedness throughout, and an energetic disposition. The reproductive organs of the boar should be clearly visible and well developed. A boar with one testicle should never be used.

Figure 295 shows the ideal meat type hog versus some of the common faults. Since no animal is perfect, the proficient swine judge must be able to recognize, weigh, and evaluate both the good points and the common faults. In addition, he must be able to arrive at a decision as to the degree to which the given points are good or bad.

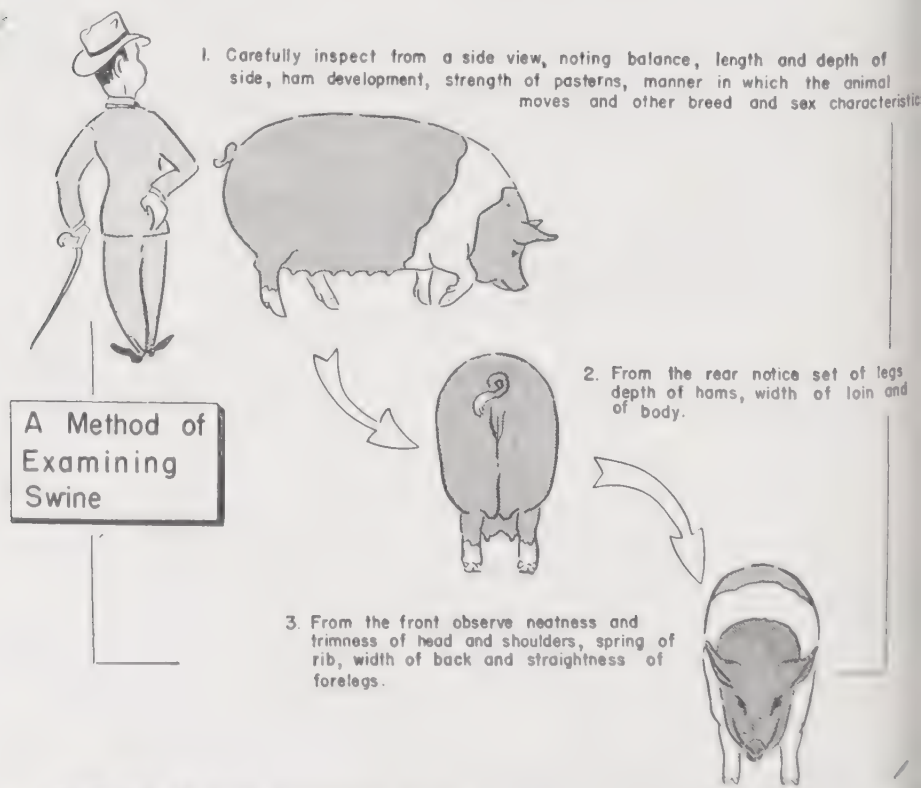


Fig. 296. A good procedure for examining a hog and some of the things for which to look. (Drawing by R. F. Johnson.)

od of Examining

Since a pig will neither stand still nor remain in the same ty long, it is not possible to arrive at a set procedure for ining swine. In this respect, the judging of hogs is made difficult than the judging of other classes of livestock. e feasible, however, the steps for examining as illustrated ure 296 are very satisfactory, and perhaps as good as any.

CHAPTER XXX

BREEDING SWINE

The laws of heredity apply to swine breeding exactly as they do to all classes of farm animals. But the breeding of swine is more flexible in the hands of man because: (1) Hogs normally breed at an earlier age, thus making for a shorter interval between generations; and (2) they are litter-bearing animals. Because of these factors, the available feeds, and the type of pork products demanded by the consumer, the American farmer has created more new breeds and made more rapid shifts in type in hogs than in any other class of farm animals.

NORMAL BREEDING HABITS OF SWINE

The pig lends itself very well to experimental study in confined conditions. It is reasonable to expect, therefore, that we should have a considerable store of knowledge relative to the normal breeding habits of swine, perhaps more than we have of any other class of farm animals.

Age of Puberty

The age of puberty in swine varies from four to six months. This rather wide range is due to differences in breeds and lines, sex, and environment—especially nutrition. In general, boars do not reach puberty quite so early as gilts.

Age To Breed Gilts

The gilt that is well developed may, as a general rule, be bred to farrow at twelve to fourteen months of age. It is to be emphasized, however, that this depends primarily upon a matter of development rather than age. Reasonably early breeding has the advantage of establishing regular and reliable breeding habits and reducing the cost of the pigs at birth. The breeding of show gilts is often delayed until after the show season. This practice frequently results in difficult conception and temporary, if not permanent, sterility. Perhaps this is due to the overfat condition in fitting.

Heat Periods

The heat period—the time during which the sow will accept the boar—lasts from two to three days on the average. Ovulation

bably occurs on the second day of heat, although evidence on latter point is not too conclusive. As in females of all species, s bred approximatley at the time of ovulation are more likely onceive than if bred at any other time. If not bred, the heat od normally recurs at intervals of eighteen to twenty-four s, with an average of twenty-one days.

The external signs of heat in the sow are restless activity, lling or enlargement of the vulva (although not always), fre- nt mounting of other sows, and occasional loud grunting.

tation Period

The average gestation period of sows is 114 days, although remes of 98 to 124 days have been reported. At the Washing- Agricultural Experiment Station, it was found that certain min deficiencies, especially a lack of riboflavin in the ration, rtened the gestation period. Pigs born from sows with such ciencies did not live, however.

eding After Farrowing

Sows will often come in heat during the first few days after rowing and will occasionally conceive if bred at that time. general, however, breeding immediately after farrowing re- s in very low fertility. Following the early postfarrowing heat od, sows normally will not again come in heat until near the of the suckling period. It is common practice to first wean litter and let the animals have a few days rest before re- eding. The most natural breeding season for sows seems to n the early summer and late autumn, although they will breed time of the year.

RTILITY AND PROLIFICACY IN SWINE

Under domestication and conditions of good care, a high ree of fertility is much desired. The cost of carrying a litter en pigs to weaning time is little greater than the cost of ducing a litter of only five or six. In other words, the mainte- ce costs on both the sow and the boar remain fairly constant. nust be remembered, however, that in the wild state high ility may not have been characteristic of swine. Survival and ural selection was probably in the direction of smaller litters, nature's plan has been reversed through planned matings and ction.

Low fertility in swine is most commonly attributed to hered- y or environmental factors. Maximum prolificacy depends n having a large number of eggs shed at the time of estrus,

upon adequate viable sperm present for fertilization at the proper time, and upon a minimum of fetal atrophy.

It is a well-known fact that some breeds and strains of swine are much more prolific than others. We are told that litters of twelve are considered normal rather than exceptional among Chinese swine. Also, through selection, more prolific strains of swine can be developed. Furthermore, the number of pigs produced increases with the age of the sow. It also appears that flushing or conditioning of sows exerts an influence on the number of eggs shed.



Fig. 297. Prolificacy in swine is much desired, for the cost of carrying a litter of ten pigs to weaning time is little greater than the cost of producing a litter of only five or six. (Courtesy, Texas A. & M. College.)

Practical swine producers generally associate type with prolificacy. To substantiate their theory, they point out that the fat, chuffy hogs in vogue during the early part of the present century were not prolific but were prone to farrow twins and triplets. Experimental work substantiates this opinion.

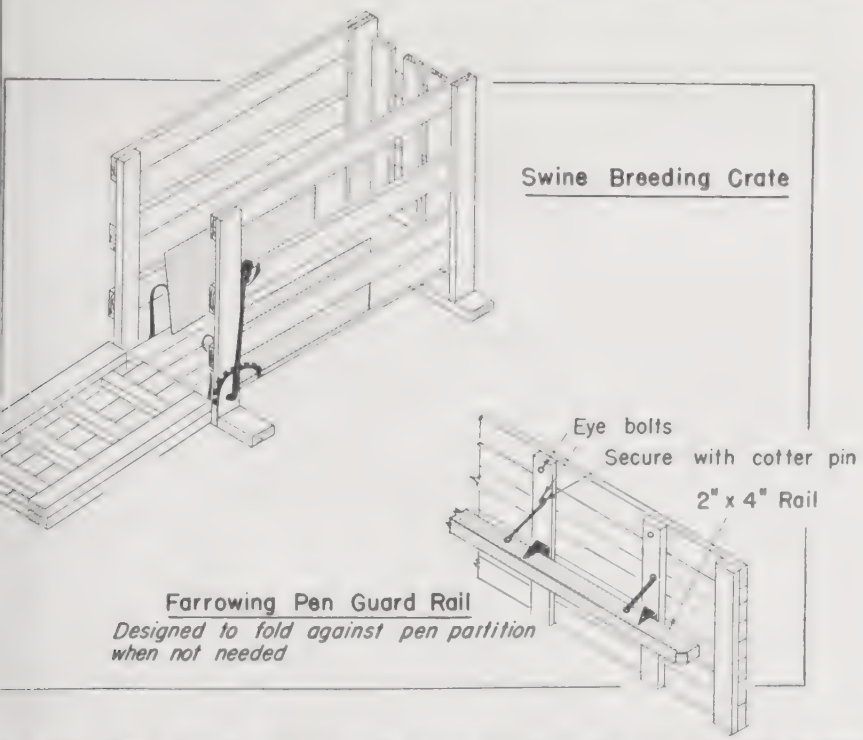
Even though many eggs may be shed and fertilized, the size of the litter may be materially affected by fetal atrophy. This condition is usually attributed to (1) hereditary factors, perhaps recessive lethals; (2) overcrowding resulting from a large number of pigs and a consequent limited uterine surface area available for the nourishment of the individual embryos; (3) nutritionally incomplete rations prior to and during gestation; (4) excessive fatness or a thin run-down condition; (5) diseases of

sites; or (6) accidents or injuries. Additional studies need e made relative to the cause and prevention of fetal atrophy. Litter size is affected little, if any, by the boar. Perhaps an ption exists in boars that are on the borderline of sterility, n insufficient viable sperm are present to fertilize the eggs. ainly, the boar cannot affect the number of eggs shed and, efore, cannot increase litter size. It has been observed that r size may be slightly increased if two services are used ead of one.

SHING SOWS

The practice of feeding sows so that they gain in weight 1 to 1½ pounds daily from about two weeks before the ing of the breeding season until they are safely in pig is n as flushing. Some of the beneficial effects attributed to practice are: (1) More eggs are shed, and this results in r litters; (2) the sows come in heat more promptly; and conception is more certain.

If sows are already overfat, the best preparation for breed- consists of conditioning by providing plenty of exercise and ss to a lush pasture, while decreasing the heavy grain ration.



ig. 298. Two handy pieces of swine equipment; the breeding crate and the guard rail (bottom). (Drawing by R. F. Johnson.)

THE BREEDING PROCEDURE; HAND-MATING; THE BREEDING CRATE

Hand-mating is more generally practiced in swine than with either cattle or sheep. In fact, it is almost the universal procedure in purebred swine herds, and many commercial producers follow the same practice.

When a mature, heavy boar is to be bred to gilts or when a boar pig is to be bred to big, rangy sows, the use of a breeding crate is recommended. Animals that have formed the habit of breeding without the crate may be rather obstinate in accepting the new method, or may refuse service altogether. Commercial swine producers usually use active, young boars; in many instances they allow the boar to run with the sows to be bred.

CARE AND MANAGEMENT OF THE BOAR

Proper care and management of the herd boar is most essential for successful swine production. Too frequently the boar is looked upon as a necessary evil and is neglected. Under such conditions, he is usually confined to a small, filthy pen—a typical "pig sty"—exercise is discouraged; and the feeding practices are anything but intelligent.

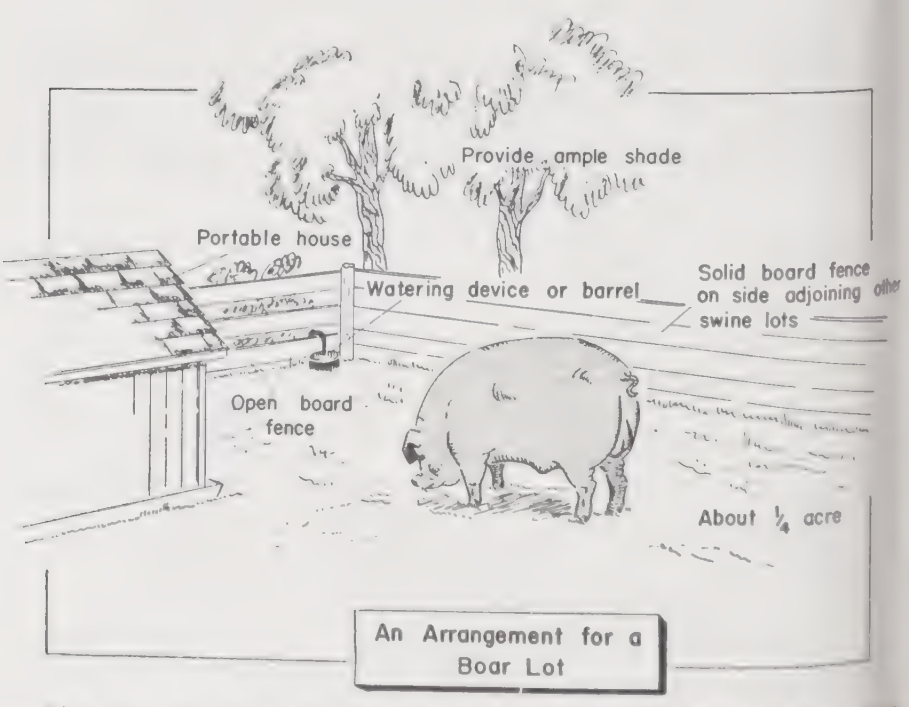


Fig. 299. Diagram of a desirable arrangement for the herd boar showing a good fence, a portable house, shade, water, and sufficient area for pasture and exercise. (Drawing by R. F. Johnson.)

d, Shelter, and Exercise

Outdoor exercise throughout the year is one of the first ntials in keeping the boar in a thrifty condition and virile. s may usually be accomplished by providing a well-fenced ure. Even then, the herdsman may find it necessary to "walk" oars or boars that are being fitted for the shows. In addition he valuable exercise that is obtained in the pasture lot, green ulent pasture furnishes valuable nutrients for the herd boar. amount of feed provided should be such as to keep the boar thrifty, vigorous condition at all times. He should neither be fat nor in a thin, run-down condition. The concentrate allow- should be varied with the age, development, and tempera- t of the individual; breeding demands; roughage consumed, Feeding the boar is more fully covered in Chapter XXXI. A satisfactory but inexpensive shelter should be provided for boar, and he should be allowed to run in and out at choice.

ting

Some boars pace back and forth along the fence, often "chop- their jaws and slobbering." Such action is called ranting. ng boars that take to excessive ranting may go off feed, be- e "shieldy," and fail to develop properly. Although this dition will not affect their breeding ability, it is undesirable n the standpoint of appearance. Isolation from other boars rom the sow herd is usually an effective means of quieting boars. Should the boar remain off feed, placing a barrow bred sow in the pen with him will help to get him back on .

ping the Tusks

It is never safe to allow the boar to have long tusks, for they inflict injury upon other boars or even prove hazardous to caretaker. Above all, such tusks should be removed well in ance of the breeding season, at which time it is necessary andle the boar considerably. The common procedure in prep- ion for removing the tusks consists of drawing a strong rope the upper jaw and tieing the other end securely to a post ther object. As the animal pulls back and the mouth opens, tusks may be cut with a bolt clipper.

E AND SERVICE OF THE BOAR

The number of services allowed will vary with the age, elopment, temperament, health, breeding condition, distribu- of services, and system of mating (hand-coupling or pasture

breeding). No standard number of services can be recommended for any and all conditions. Yet the practices followed by good swine producers are not far different.

For best results, the boar should be at least eight months old and well grown before being put into service. Even then, he should be limited to one service per day and a maximum total of two dozen services during his first breeding season, unless the mating period covers more than one month.

When fed and cared for by an experienced herdsman a strong, vigorous boar from one to four years of age (the period of most active service) may serve two sows per day during the breeding season provided that a system of hand-coupling is practiced. With pasture mating, fewer sows can be bred.

A boar should remain a vigorous and reliable breeder up to six or eight years of age or older, provided that he has been managed properly throughout his lifetime.

CARE OF THE PREGNANT SOW

Without attempting to review the discussion on feeding the gestating sow as found in Chapter XXXI, it may be well to re-emphasize that there are two cardinal principles which the feeder should keep in mind when feeding sows during the pregnancy period. These are: to provide a ration which will insure the complete nourishment of the sow and her developing fetal litter and to choose the feeds and adopt a method of feeding which will prove economical and adaptable to local farm conditions.

In addition to having proper nutrition, the pregnant sow should have regular and careful exercise. During periods of inclement weather and when feed is brought into the house, sows quite often exercise too little. As a result, they become sluggish and the blood circulation is poor. Forced exercise may be brought about by feeding some distance from the house or by driving the animals at a moderate walk. Sows that have had plenty of exercise during the gestation period generally encounter less difficulty at farrowing time and produce stronger pigs.

The shelter for the bred sows should be neither elaborate nor expensive. Less labor is involved when several sows of the same age, size, and condition are run together. The chief requirements are that the shelter be tight overhead, that it afford protection from inclement weather, that it is well drained and dry and that it is of sufficient size to allow the animals to move about and lie down in comfort. Except during the most inclement

ner, the sows should be encouraged to run outdoors where will get exercise, fresh air, and sunshine.

E OF THE SOW AT FARROWING TIME

The careful and observant herdsman realizes the importance ving everything in readiness for farrowing time. If the ant sows have been so fed and managed as to give birth to of strong, vigorous pigs, the next problem is that of saving igs at farrowing time.



g. 300. Washing the sow prior to moving into the farrowing quar- his removes adhering parasite eggs (especially the eggs of the com- ound worm) and disease germs. (Courtesy, Prof. E. F. Ferrin, Uni- of Minnesota.)

t has been conservatively estimated that from 30 to 35 per of the pigs farrowed never reach weaning age, and an addi- loss of 5 to 10 per cent occurs after weaning. This means nly 60 per cent of the pig crop reaches market age.

S OF APPROACHING PARTURITION

The immediate indications that the sow is about to farrow xtreme nervousness and uneasiness; an enlarged vulva, and sible mucous discharge. She usually makes a nest for her g, and milk is present in the teats.

ration For Farrowing

About three or four days prior to farrowing, the sow should olated from the rest of the herd. It is important, however,

that moderate exercise be continued while the animal is in the farrowing quarters.

SANITARY MEASURES:

Before being moved into the farrowing quarters, the sow should be thoroughly scrubbed with soap and warm water, especially in the region of the sides, udder, and undersurface of the body. This removes adhering parasite eggs (especially the eggs of the common round worm) and disease germs.

The house should be thoroughly cleaned to reduce possible infection. This may be done by scrubbing the walls and floors with boiling-hot lye water made by using one can of lye to 15 gallons of water. If the farrowing house has dirt floors, the top 2 or 3 inches of soil should be replaced by an equal quantity of clean clay soil. The sow should then be placed in her new quarters.

THE QUARTERS:

Hogs are sensitive to extremes of heat and cold and require more protection than any other class of farm animals. This is especially true at the time of parturition.

The main requirements for satisfactory housing are that the quarters be dry, sanitary, and well ventilated and that they provide good protection from heat, cold, and winds. The buildings should be economical and durable.

THE GUARD RAIL:

A guard rail around the farrowing pen is an effective means of preventing sows from crushing their pigs. The importance of this simple protective measure may be best emphasized by pointing out that approximately one-half of the young pig losses are accounted for by those pigs that are laid on by their mothers. The rail should be raised 8 to 10 inches from the floor and should be 8 to 12 inches from the walls. It may be constructed of two-by-fours, two-by-sixes or strong poles.

BEDDING:

Plenty of clean, fresh bedding should be provided at all times. Any good absorbent that is not too long and coarse is satisfactory. Wheat, barley, rye, or oat straw; short or chopped hay; and shredded corn fodder are most commonly used.

The Attendant

The herdsman should be on the job, especially during times of inclement weather. It may be necessary to free the newborn pigs from the enveloping membrane and to help them reach the

ner's teat. In cold weather the young should be dried off and r precautions taken to avoid chilling.

If the sow has labored for some time with little progress or boring rather infrequently, assistance should be given. This lly consists of inserting the hand and arm in the vulva and ly correcting the condition preventing delivery. Before doing the fingernails should be trimmed closely, and the hands and should be thoroughly washed with soap and warm water, fected, and then lubricated with vaseline or linseed oil.

As soon as the afterbirth is expelled, it should be removed the pen and burned or buried in lime. This prevents the sow eating the afterbirth and prevents the development of bac- and foul odors. Many good swine producers are convinced eating the afterbirth encourages the development of the pig- g vice. Dead pigs should be removed for the same reason.

It is also well to work over the bedding; remove wet, stained, iled bedding and provide clean fresh material.

ed and Weak Pigs

Pigs arriving during cold weather are easily chilled. Under conditions, it may be advisable to take the pigs from the ner as they are born and to place them in a half-barrel or et lined with straw or rags. In extremely cold weather, a few bricks or a jug of warm water (properly wrapped to prevent s) may be placed in the barrel or basket; or the pigs may be n to a warm room until they are dry and active.

One of the most effective methods of reviving a chilled pig immerse the body, except for the head, in water as warm as elbow can bear. The pig should be kept in this for a few utes, then removed and rubbed vigorously with cloths.

an Pigs

Pigs may be orphaned either through sickness or death of mother. In either event, the most satisfactory arrangement he orphan is to provide a foster mother. When it is impos- to transfer the pigs to another sow, they may be raised on s milk. The problem will be simplified if the pigs have re- ed a small amount of colostrum (the first milk) from their ner.

It is preferable to use milk from a low-testing cow. The first or three days the orphan should be fed regularly every two s, and the milk should be at 100 degrees Fahrenheit. There- r, the intervals may be spaced farther apart. All utensils

(pan feeding or a bottle and nipple may be used) should be clean and sterilized.

Artificial Heat

During times of inclement weather, artificial heat usually must be provided, especially for pigs farrowed in the northern United States. Most large central hog houses are equipped with a heating unit for use in winter farrowing.

Individual houses may be insulated by banking with straw and other insulating materials. Then a lantern or oil burner may be suspended from the top of the house. It must be remembered, however, that there is considerable fire hazard from this practice. The electric pig brooder is a much safer heating unit for either the central or the movable hog houses. The principles involved are identical to those of the electric chick brooder.

THE SOW AND LITTER

The care and management given the sow and litter should be such as to get the pigs off to a good start. As is true of other young livestock, young pigs make more rapid and efficient gains than older hogs. Strict sanitation and intelligent feeding are especially important for the well-being of the young pig.

The McLean County System of Swine Sanitation

The McLean County system of swine sanitation (see Fig. 301) was worked out especially for the purpose of preventing infestation of young pigs with the common roundworm. The application of these principles is usually effective in reducing trouble from other parasities and in disease control—thus making possible cheaper and more profitable pork production.

The Needle Teeth

Newborn pigs have eight small, tusk-like teeth (so-called needle or black teeth), two on each side of both the upper and lower jaw. As these are of no benefit to the pig, most swine producers prefer to cut them off soon after birth. This operation may be done with a small pair of pliers or with forceps made especially for the purpose. In removing the teeth, care should be taken to avoid injury to the jaw or gums, for injuries may provide an opening for germs. The needle teeth are very sharp and are often the cause of pain or injury to the sow, particularly if the udder is tender. Moreover, the pigs may bite or scratch each other and infection may start and cause serious trouble.

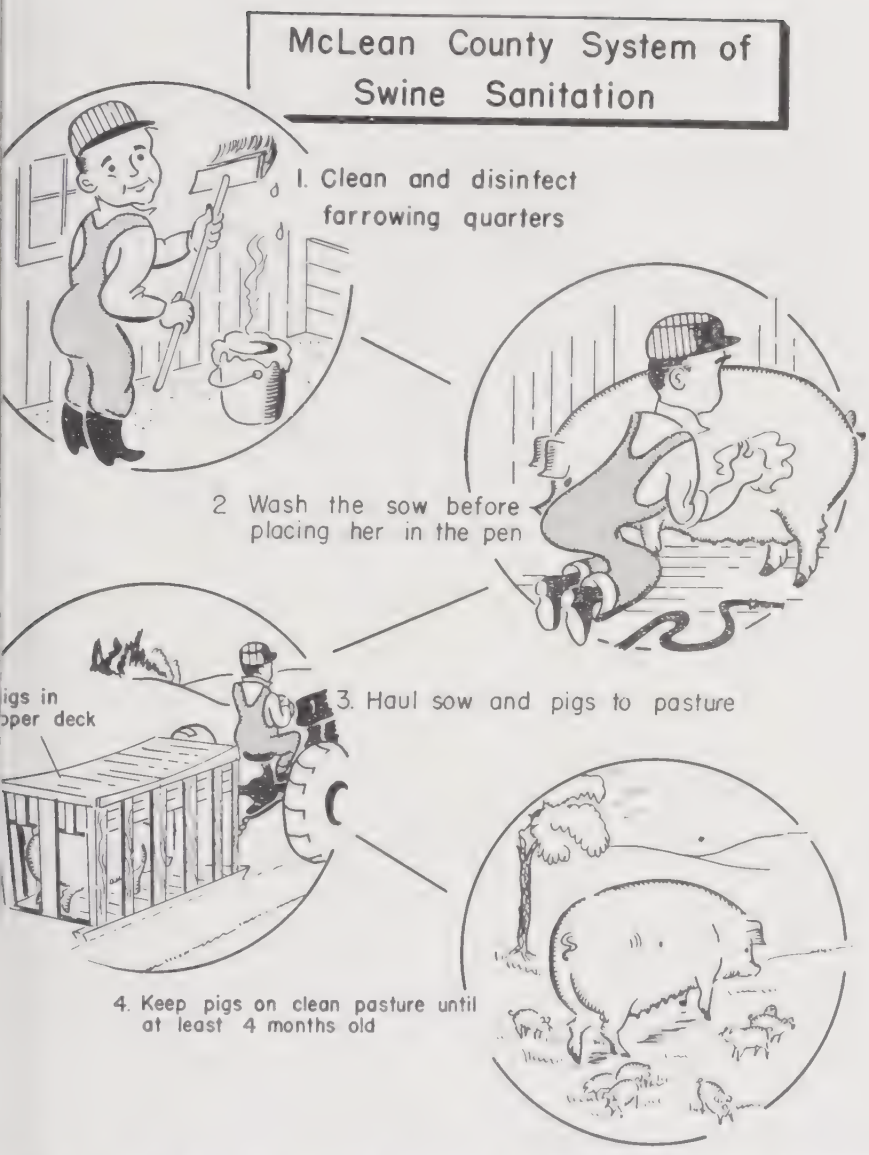


Fig. 301. The McLean County System of Swine Sanitation involves our simple steps shown in the diagram, namely (1) cleaning and dis-ting the farrowing quarters, (2) washing the sow before placing her e farrowing quarters, (3) hauling the sow and pigs to clean pasture, (4) keeping the pigs on clean pasture until they are at least four ns old. (Drawing by R. F. Johnson.)

Notching the Litters

Pigs are generally marked at the same time that the needle n are removed. Purebred breeders find it necessary to employ stem of marking so that they may determine the parentage ne individuals for purposes of registration and herd records. n in the grade herd, a system of identification is necessary

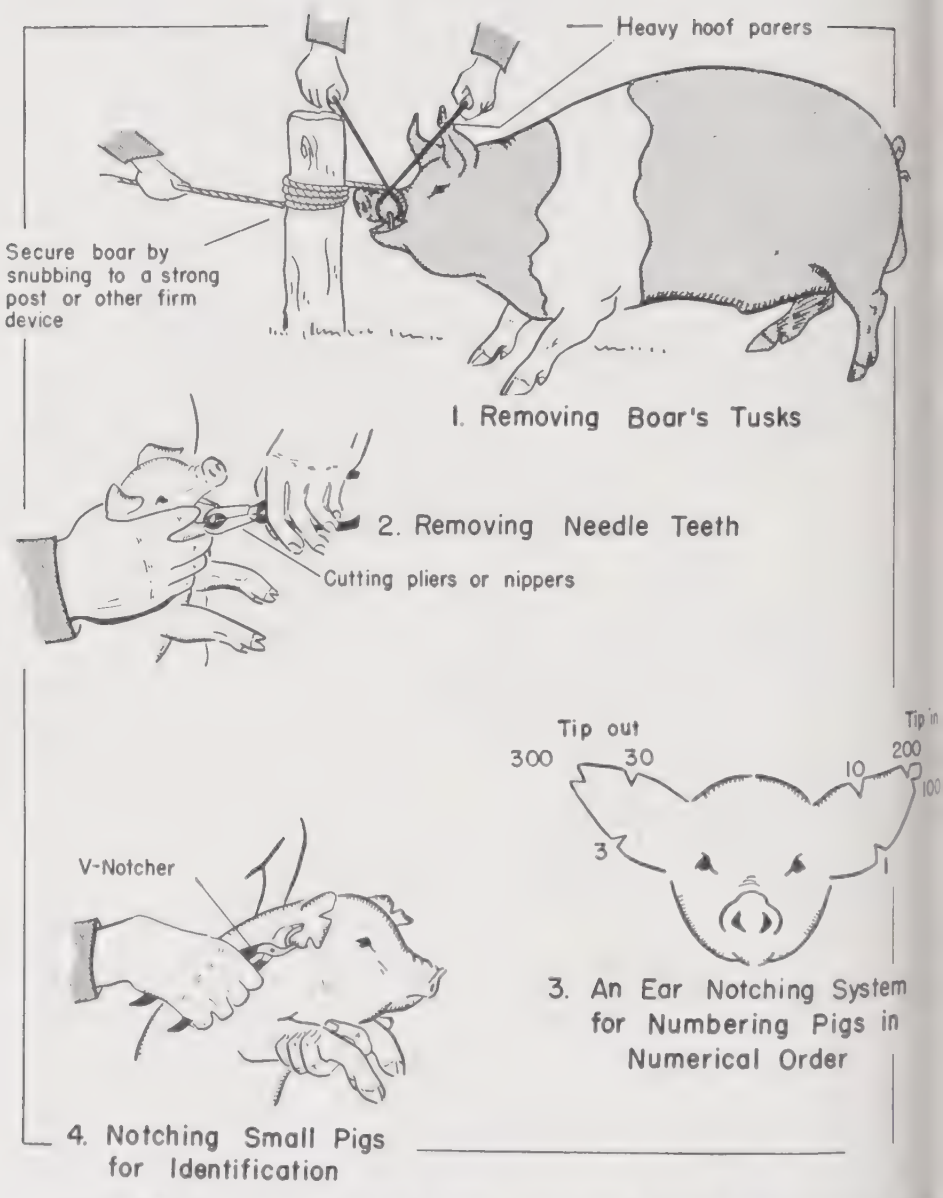


Fig. 302. Diagrams showing some important swine management practices: (1) removing boar's tusks, (2) removing needle teeth, (3) an ear notching system for numbering pigs in numerical order, and (4) notching small pigs for identification. (Drawing by R. F. Johnson.)

if the gilts are to be selected from the larger and more efficient litters. The ear notches are usually made with a special ear marker or an ordinary harness punch. No universal system is employed; each individual producer has his own ideas upon the subject. Most of the breed associations are in a position to recommend a satisfactory marking system.

ration

All male pigs that are not to be used for breeding purposes ld be castrated while they are still suckling their dams. They ld be castrated early enough to allow plenty of time for the ids to heal thoroughly before weaning. It should not be done e same time that the pigs are vaccinated. In preparation for peration, the pigs should be kept off feed ten to twelve hours.

Before starting the castrating, the hands should be thohly washed with soap and water and rinsed in a good disinnt. The knife should be disinfected both before and between ations; and the scrotum of the pig should be washed before after making the incision. A coal tar dip, used according to directions found on the container, will be satisfactory. The should be sharp, and the slit should extend well down so as low for proper drainage. In young pigs, the cord should be d out or broken off well forward.

cise and Sunshine

During seasons of the year when the weather is warm, the natural and ideal place for the sow and litter is on a clean re, away from other livestock. Exercise, fresh air, and sun- make for a good start in life.

The ideal arrangement is a movable hog house on clean pas- preferably on land that has been plowed since hogs were on the area.

Requirements of the Nursing Sow

After farrowing, the sow should be brought back on feed gradually, arriving at full feeding ten days to two weeks . Throughout the lactation period, she should be fed liberally feeds that will stimulate milk production. The most essential in the brood sow's ration during this period is an ample nt of protein, vitamin, and mineral substances.

MAL BREEDING SEASON AND TIME OF FARROWING

The season in which the sows are bred and the question of ng one or two litters a year, depend primarily on the facilat hand. The location of the producer (particularly the her conditions in the area), availability and price of feeds, ition and growth of the sows, equipment for handling pigs g the winter months, available labor, and the type of proon (purebred or commercial) should be taken into considera- No positive advice can be given, therefore, for any and all

conditions. Sows will breed any time of the year, but as in other farm animals, the conception rate is much higher during those seasons when the temperaure is moderate and the nutritive conditions are good. For the country as a whole, spring pigs are preferred, as is shown by the size of the spring pig crop in comparison with the fall pig crop.

Show-Yard Classifications May Determine Farrowing Dates

The purebred breeder who exhibits breeding hogs should plan the breeding program so that the maximum advantage will be taken of the various age groups.

TWO LITTERS VERSUS ONE LITTER A YEAR

Whether to have each sow farrow two litters or one litter per year is a problem that each individual swine producer must decide. Where climatic conditions, facilities, and feeds are favorable to the two-litter system, it has the following distinct advantages:

1. Maximum use is made of the capital invested in facilities and equipment.

2. More certain and rapid improvement can be effected in the breeding herd through maintaining outstanding tried sows throughout their useful lives. The two-litter system is conducive to retaining such sows.

3. There is a better distribution of labor.

4. Pigs are marketed at two different times of the year, thus distributing risks.

5. There is better distribution of farm income.

On the other hand, in the northern latitudes where suitable facilities and feeds may not always be available, the following disadvantages often apply to the two-litter system:

1. It is necessary that the spring-farrowed litter arrive reasonably early, often during inclement weather. Young pig losses, under such conditions, are higher than is usually encountered in a one-litter system.

2. Except in the South where nearly year-around pasture are available, fall farrowed pigs require more concentrates and high-priced protein supplements than pigs born earlier in the year and run on pastures. Because of inadequate nutrition, many fall pigs also are less thrifty and make slower gains than pigs run on pasture.

Because of the high cost in maintaining tried sows for a whole year to raise one litter of pigs, the one-litter system is

ally based chiefly or entirely on the use of gilts that are fat-
d and marketed soon after weaning their litters.

TS VERSUS OLDER SOWS

Controlled experiments[1] and practical observations, in which
s have been compared with older (tried) sows, bear out the
wing facts: (1) Gilts have fewer pigs in their litters than
lder sows and (2) the pigs from gilts average slightly small-
n weight at birth and also tend to make somewhat slower
s.

Despite the disadvantages listed above, gilts have certain
ntages, especially for the commercial pork producer. Their
f superiority lies in the fact that they continue to grow and
ease in value while in reproduction. Although overweight
ng sows bring less on the market than prime barrows, from
standpoint alone they generally return a handsome profit
n the price of pork is sufficiently favorable. Many practical
mercial producers, who probably are less close to the herd
arrowing time than purebred breeders, are of the opinion
the smaller gilts crush fewer pigs than do older and heavier
s.

In no case is it recommended that the purebred breeder
only on gilts. Tried sows that are regular producers of large
rs with a heavy weaning weight and that are good mothers
producers of progeny of the right type should be retained
ne herd as long as they are fertile. This procedure is neces-
to herd improvement.

SSBREEDING SWINE

Crossbreeding has been more widely applied in swine than
ny other class of livestock. Yet no system of breeding has
the object of greater controversy or more heated arguments.
ne discussion that follows, the writer will merely attempt to
ain the different methods and point out some of the advan-
s and disadvantages, with the hope that the reader may be
er able to arrive at an independent evaluation of the merits
emerits of the system.

Crossbreeding is one of the three tools through which
al improvement may be brought about; the other two are
tion and inbreeding. Genetically speaking, crossbreeding
notes the pairing of unlike genes by mating of animals that

[1] Experiments of this type were conducted at the North Dakota and
nsin Stations.

belong to different species (the horse and the ass cross produces mules or hinnys), to different breeds (a Duroc X Poland China cross), or to different families (crossing two families within a breed).

Specie crosses with swine are of no importance. The value of family crosses remains to be seen. It is predicted by some geneticists, however, that some rather important results may come out of crossing highly inbred strains of swine within the same



Fig. 303. Champion carload of crossbred barrows at the 1946 Pacific International, Portland. Bred and exhibited by the State College of Washington. These bacon type barrows are descended from a Landrace X Chester White foundation. (Courtesy, State College of Washington.)

breed. The program of the Regional Swine Breeding Laboratory is designed to give the answer to this and other perplexing questions. Crossing between breeds has long been a common practice among commercial swine producers.

The chief reasons for crossbreeding in swine or in any other class of farm animals are:

1. It may bring about an increase in vigor, commonly known as hybrid vigor or heterosis. In this connection, the term "vigor" is broadly used to cover such things as rate of gain, economy of gain, fertility, and general strength.

2. It constitutes the most rapid system of breeding through h new genes may be introduced in order to secure improved ties. As undesirable qualities are generally recessive, cross- ding offers the best way in which to improve certain charac- tics merely by hiding them with dominants.

3. It creates new breeds. It must be remembered that there thing sacred about present existing purebreds. They will l or fall on their own merits. There is no need to create a breed, however, unless the combination of characters that reed possesses fulfill a specific need better than any existing l.

4. It may be used to produce market animals. It must be zed, however, that the continued improvement in any class rm animals will always rest on superior purebreds.

In commercial swine, where crossbreeding has been most nsive, the usual method is to use purebred boars on purebred gh-grade sows of another breed. This first cross generally ts in hybrid vigor of some importance; but, if these cross- animals are to be retained in the breeding herd, these ad- ages can only be maintained through continued heterosis. kers at the Minnesota Experiment Station have suggested a continued and long-time program of crossbreeding in swine be carried out by either of the following methods:

1. Crisscrossing.—In which selected crossbred gilts, pro- l by maturing sows of breed "A" to a boar of breed "B," are back to a boar belonging to one of the parent breeds (boar of "A"). Then selected offspring from this mating are next back to a boar of breed "B."

2. Triple crossing.—In which first cross gilts are mated to ar of a third breed. The program is then continued through ing the sires among the three breeds. This plan is being ved by many progressive commercial producers located in Corn Belt.

Although somewhat conflicting results have been reported, ems reasonable to expect that crossbreds obtained through r of the above two methods or through the crossing of two breeds will possess some advantage over purebreds in terms te and efficiency of gains. In Washington Agricultural Ex- ment Stations Bulletin No. 189, Dr. E. J. Warwick reports llows: "The author has summarized the data from a large ber of crossbreeding experiments and has found that on the age crossbred animals apparently exceed the average of the

purebred animals used in making the crosses by a matter of about 3 per cent in pounds of pork produced per litter at six months of age, with the better crosses more productive than this."

On the other hand, the following disadvantages are especially applicable to crisscrossing and triple-crossing systems:

1. Generally speaking, a crossbred hog lacks the uniformity in color and general attractiveness of purebreds.

2. Desirable boars of the two or three breeds must be located and purchased.

3. Unless all the breeding is on a gilt basis, more than one boar must be maintained at all times.

4. If the young sows go to market after farrowing only one litter, little constructive selection can be practiced.

Whether or not crisscrossing or triple-crossing should be followed in a commercial swine herd is questionable. The reported 3 per cent increase in pork produced is relatively small. Moreover, it must be weighed against the very definite disadvantages that are listed.

In addition to the crossbreeding systems referred to as crisscrossing and triple-crossing, crossbreeding often is held to a system involving only *first crosses between high-grade or purebred parents of different breeds*. If this system is followed, the breeder is faced with the problem of sooner or later breeding the females back to a purebred boar of the same breed in order to secure replacement females. Under these conditions, the breeder is prone to make little or no selection and to keep all of the females for replacement purposes. In such a program, it is usually found that the breeder does well merely to maintain the quality of the female herd.

In summary, it may be said that interbreed swine crossbreeding programs are of three types: (1) first breed crosses between two purebred parents of different breeds, (2) crisscrossing, and (3) triple-crossing. If crossbreeding is to be followed the advantages and disadvantages of each system should receive careful consideration. Also, crossbreeding should not be looked upon as a panacea for neglect of sound practices of breeding, feeding, management, and sanitation. Neither should it be assumed that the virtues of crossbreeding are sufficiently powerful to alleviate the necessity of selecting an outstanding boar rather than a scrub.

It should be understood that the disadvantages of crossing two breeds do not generally apply to the systems of crossbreeding

een families or to the creation of a new breed when that s desirable.



ig. 304. Pig with "thick forelegs," a lethal condition caused by a sim-cessive genetic factor. (Courtesy, Dept. of Veterinary Pathology and ne, College of Veterinary Medicine, University of Illinois.)



ig. 305. Hydrocephalic (literally meaning "water in the head") Duroc igs affected with this condition die soon after birth. It is inherited as ple recessive. (Courtesy, Dr. E. J. Warwick, Purdue University.)

LETHALS AND OTHER HEREDITARY ABNORMALITIES IN SWINE

Lethal characters in swine or in any class of animals are caused by the presence of hereditary factors in the germ-plasm that produce an effect so serious as to cause the death of the individual either at birth or later in life. Some of the lethals and other abnormalities that have been reported in swine are summarized in Table 57. Breeding animals possessing hereditary lethals should be culled from the herd.



Fig. 306. A six legged Duroc gilt farrowed in 1948 on the farm of Ray L. Peterson, Oneida, Illinois. Perhaps this condition can best be described as an "accident of development." (Courtesy, Ray L. Peterson, Oneida, Illinois.)

PRODUCTION TESTING SWINE

As pointed out in Chapter II, the effectiveness of selection can be increased provided that it is based upon carefully taken records rather than upon casual observation. Naturally, it would be illogical to expect upstanding, narrow-bodied, shallow sows and boars to beget well-balanced, deep, meat-type barrows that would be market toppers. Breeding animals of acceptable meat type can only transmit these qualities unfailingly to all their offspring when they themselves have been rendered relatively homozygous or pure for the necessary genes—a process that can be gradually accomplished through judgment by close

Type of abnormality	Description of abnormality	Probable mode of inheritance
A. LETHALS		
Artesia ani	Closure of the anal opening. Pigs born alive.	?
Brain hernia	Pigs usually born alive but skull openings present involving frontal and parietal bones.	Probably recessive
Catlin mark	Incomplete development of the skull.	Recessive
Cleft palate	Pigs born alive but unable to nurse.	Recessive
Hydrocephalus	Fluid on the brain; head enlarged; often accompanied by short tail.	Recessive
Legless	Pigs born alive but without legs.	Recessive
Muscle contracture	Usually only forelegs affected, but sometimes hind legs are involved. Forelegs rigid. Animals usually still-born or live only short time.	Recessive
Paralysis	Complete paralysis of hind legs. Born alive but starve unless given special care.	Recessive
Split ears	Usually associated with cleft palate and deformed hind legs.	Probably recessive
Thickened forelimbs	Thickening of forelegs caused by infiltration of connective tissues which replace the muscle fibers. Pigs usually born alive.	Recessive
B. NON-LETHALS		
Cryptorchidism	One or both testicles retained in body cavity.	Recessive
Hair whorls (swirls)	Hair at a given point in back region flanges out in all directions.	Mode of inheritance not certain but probably due to complimentary action of 2 dominant factors.
Hairlessness	Animals born with little or no hair (not to be confused with hairlessness caused by an iodine deficiency).	?
Hemophilia	Blood fails to clot promptly.	Recessive
Inverted nipples (blind teats)	Teats inverted and nonfunctional.	Recessive
Scrotal hernia	Ruptured; intestines extending into scrotum.	Result of two pairs of recessive factors

eye method but which can be made more rapid and certain through securing and intelligently using production records.

The following characteristics in swine are relatively easy to recognize and measure and are a fairly accurate guide in estimating the economy of production:

1. Litter size and survival.
2. Weight per pig and per litter at weaning time.
3. Daily gains between weaning and marketing.
4. Body type.
5. Pounds of feed per each hundred pounds of gain.



Fig. 307. An outstanding Production Registry Hampshire sow, bred and owned by Neal E. Tourtellotte, Janalu Farm, Seattle, Washington. Janalu Roller Susabelle 845676*** P.R. No. 297, shown above, was farrowed October 9, 1944. Her first three litters made records as follows: No. 1 farrowed October 9, 1945, nine pigs raised to 56-day weight of 387 pounds; No. 2 farrowed March 31, 1946, nine pigs raised to 56-day weight of [illegible] pounds; No. 3, farrowed September 27, 1946, ten pigs raised to 56-day weight of 340 pounds. (Courtesy, Neal E. Tourtellotte.)

That swine show variations in these characteristics is generally recognized. The problem is to measure these differences from the standpoint of discovering the most desirable genes and then increasing their concentration and, at the same time, to purge the herd of the less desirable characters.

The first two items listed measure the prolificacy and mothering ability of the sow. On the average, a sow will have consum-

WASHINGTON STATE COLLEGE
DEPARTMENT OF ANIMAL HUSBANDRY
LITTER RECORD, FARROWING TO WEANING

Sow No._____ Litter Serial No._____

of birth, sow_____Age_____ (Years) Farrowing date of litter_____

Litter _____ (1st, 2nd, etc.)

sire_____

dam_____ Sire of litter, No._____

of inbreeding (F):

_____ Litter castrated (date)_____

er_____ Litter vaccinated: Erysipelas_____

Cholera_____

DESCRIPTION, SOW

rowing:_____ At Weaning:_____

dition Good___Med.___Thin__ 1. Condition Good___Med.___Thin__

mperament Gentle_____ Mod. 2. Number functioning teats___ __

tle_____ Wild_____ 3. Remarks: _____

mber good teats_____ _____

cial traits_____

o.	Sex	**At birth** Weight (lbs.)	Condition[1]	**At 56 days** Weight (lbs.)	Disposal after weaning	Remarks[2]

DESCRIPTION, LITTER AS A WHOLE

h:_____ At weaning:

eral appearance: 1. General appearance:

d____ Medium____ Poor_____ Good____ Medium____ Poor_____

fects and abnormalities[3]_____ 2. Defects_____

or markings_____ _____

g. 308. Litter record form in use at the State College of Washington.

ord as excellent 9; good 7; medium 5; fair 3; inferior 0.
ord date and cause of death.
ord notes of abnormalities for individual pigs under remarks or on back of this sheet.

a total of three-fourths to one ton of feed during the peri between breeding and the date her litter is weaned. Thus, if th quantity of feed must be charged against a litter of four or fi pigs, the chance of eventual profit is small. Aside from measurin the milking ability of the dam, weaning weight of the litter i important, for it has been shown that the pigs that are th heaviest at weaning time reach market weights more quickly.

Finally, it should be recognized that swine are raised primar ily for profit, and profit is dependent upon efficiency of productio and market price. Fortunately, the factors making for efficienc of production—including litter size and survival, growth rat and feed efficiency—do not change with type fads. For this rea son, emphasis should be placed on a proper balance of the produc tion factors. It might well be added that type changes, quit likely, would not be so radical as in the past if they were guide by market demands based on carcass values. These facts sho clearly enough that production testing will lend stability to swi breeding operations, from the standpoint of both efficiency o production and type.

The litter record form in use at The State College of Was ington is shown in Figure 308.

Production Testing By Swine Record Associations

At the present time, several of the swine registry associ tions of the United States have a system of production testi known as Production Registry (PR). The rules governing the registries are very similar in the breeds and generally inclu the following:

1. The registries are available only to registered purebre not possessing any outstanding faults.

2. Litters must be ear-notched at farrowing.

3. Weaning weights of litters are taken at fifty-one to six one days with witnesses and are calculated to a fifty-six-d basis.

4. Production registry (PR) litters consist of eight or m pigs farrowed and raised without the aid of a nurse sow. W fifty-six-day litter weights as follows: (1) for a sow over fift months of age at farrowing time, at least 320 pounds; and for a gilt fifteen months of age or younger at farrowing ti at least 275 pounds.

5. To qualify, a sow must produce two PR litters. Produ tion Registry sows will be classified according to the number qualifying litters raised as 2-star, 3-star, etc.

A boar becomes "PR Boar" when he has sired fifteen re official PR qualifying litters; or "one-star PR Boar" he has sired five 2-star PR daughters, or ten 1-star PR ters, or an equivalent combination of both. A boar may for another star for each additional ten points on the of PR daughters.

Breed associations urge testing of whole herds of sows than a selected few.

hus, in addition to pedigreeing, protecting, and promoting, ine record associations of America are now adding proving list of services rendered. Swine production testing as now ed in this country is relatively simple, and where it has ried, the breeders are convinced of its merits. It merely es marking the pigs in each litter—a practice followed rebred breeders, anyway—then weighing them at eight of age and recording the weights. If the pigs in a litter measure up to a certain standard, they and their parents be discarded from the breeding herd. In a purebred herd, gs must also measure up to the standards of the breed. ain criterion or yardstick, however, is the total litter weight aning time, for the reason that results, in most instances, that the heaviest pigs at weaning time are also the heaviest rketing time. One hundred and eighty-day weights plus ls of feed consumption would be desirable, but these are difficult to obtain and are not entirely necessary.

he purpose of Production Registry testing in swine is to size practical utility points and to enable breeders to co-ate outstanding individuality (type) with equally outstand-oduction ability. In addition to providing a basis for more gent selection of breeding stock, such production records h valuable information for advertising purposes.

CHAPTER XXXI

FEEDING SWINE

In the natural state, the wild boar roved through the forests gleaning the feeds provided by nature; whereas on a modern farm the range is restricted and sometimes entirely devoid of vegetation. Domestic swine have less choice in their selection of feed than any other class of livestock. For the most part they are able to consume only what the caretaker provides. This consists largely of concentrated feeds with only a small proportion of roughage. These conditions are made more critical because hogs grow much faster in proportion to their body weight than the larger farm animals, and they produce young at an earlier age. Thus a knowledge of the nutritional needs of swine is especially important.

Extensive surveys indicate that 30 to 35 per cent of all pigs farrowed fail to live to weaning age. Although these heavy losses are due to many and variable factors, certainly nutritional deficiencies play a major role.

SPECIFIC NUTRITIVE NEEDS OF SWINE

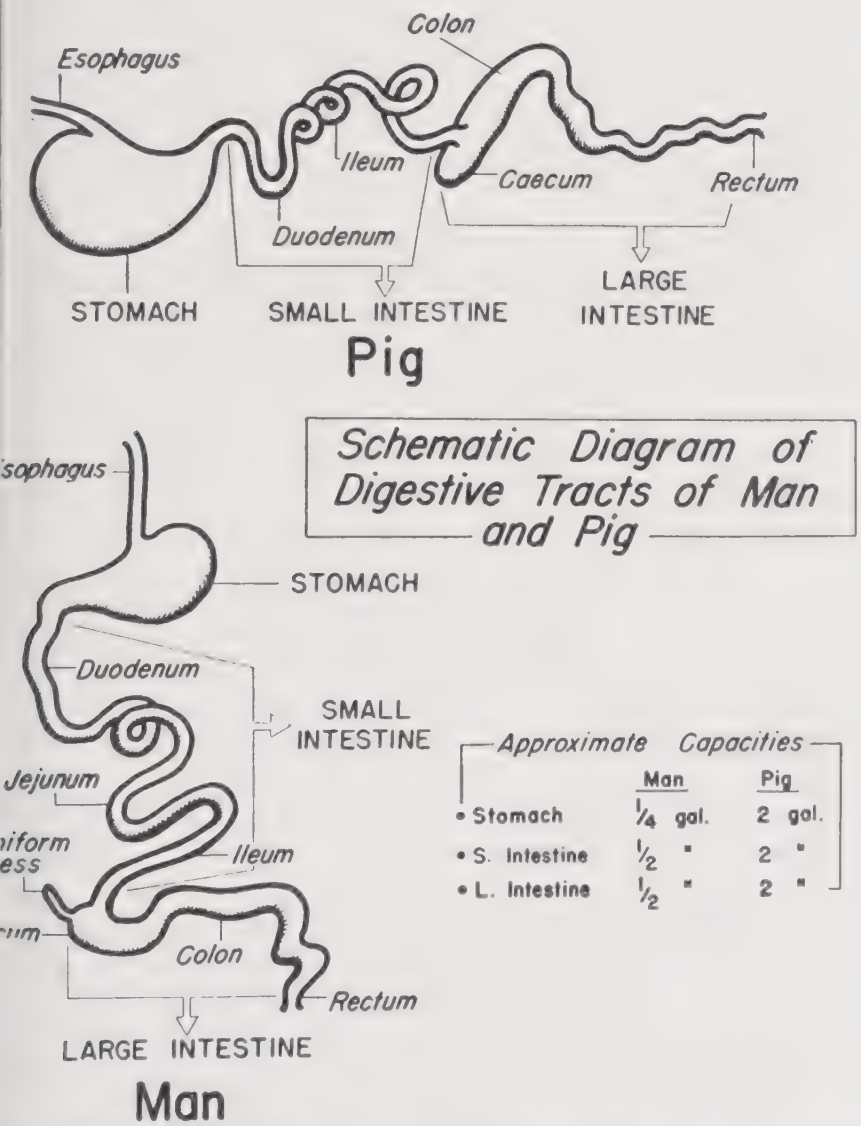
The feed requirements of swine vary according to the purpose for which the animals are kept. The ration for fattening hogs should be quite different from that supplied to prospective breeding animals, and the ration for brood sows should differ from both of these. There are, however, certain basic nutritive needs for all classes of swine. These nutritive requirements are:

1. An adequate supply of proteins of good quality for maintenance and the building of muscle tissue.
2. A certain amount of energy for maintenance and fattening.
3. The necessary minerals for the body framework and the normal physiological processes of the body.
4. Those vitamins that are recognized as essential for the growth and well-being of the animal.
5. Water.

Protein Needs

Protein feeds are essential for maintenance and building of body tissue. In swine feeding, protein is most frequently the

ng factor in the ration, both from the standpoint of quantity uality. This is due to the fact that the common farm grains heir by-products—which constitute the chief diet of pigs—ow in protein content, and their proteins are lacking in the tial amino acids. Moreover, the digestive tract of the pig is dapted to the synthesis of proteins by micro-organisms as is aunch of ruminants. Also, since protein supplements are the expensive, there is a temptation to feed too little. The pro-in the ration is of special importance for young, growing



ig. 309. Because of their similar digestive tracts and body sizes the ive requirements of the pig and man are much alike. Note that both a simple monogastric stomach. (Drawing by R. F. Johnson.)

pigs and for gestating-lactating sows—the so-called critical periods in swine production.

Improvement in the quality of proteins of cereal grains and their by-products can be achieved through various combinations of feeds. In swine feeding, proteins of animal origin (skim milk, fish meal, *good* quality tankage, etc.) are regarded as having a higher feeding value than those of vegetable origin (soybean meal, linseed meal, peanut oil meal, cottonseed meal, etc.). For economic reasons, however, the two types are usually combined. For example, linseed meal is unsatisfactory as the sole protein supplement for young pigs; but when it is used in combination with a good protein supplement of animal origin, satisfactory results are secured. Although the protein supplements are higher in price than the carbohydrate feeds, the cash outlay usually yields greater returns in increased rate of gain and better utilization of feed.

Young pigs require a much greater proportion of protein in the ration than do those that are approaching market weight. Accordingly, for most economical results the ration of the pig should be changed at different stages of growth. The recommended protein levels for different weight groups are as follows:

Range in weight of pigs	Protein content of ration (per cent)
Weaning to 75 pounds	20
75 to 125 pounds	16
125 to 200 pounds	14
Gestating and lactating sows	15 to 16

If the pigs are being self-fed, the protein supplements may be provided free choice. Fortunately, pigs show a remarkable ability to balance their own rations when allowed to choose from several feeds cafeteria style. The protein supplements may either be combined as a mixture, or each type of ingredient may be fed in a separate compartment. An exception should be made to the latter method of providing the protein supplement when the grain ration consists of barley, oats, rye, or kafir. When fed these grains, pigs usually consume more of the protein supplement than necessary, thus reducing the economy of the ration. Likewise, when corn is fed as the grain, sometimes such protein supplements as (1) roasted soybeans, (2) soybean oil meal, and (3) mixtures of tankage or fish meal and soybean oil meal are too palatable to be fed separately from the corn.

Young, lush pastures and early-cut, green, leafy alfalfa are sources of good quality proteins as well as excellent sources of

vitamins and unknown factors. Thus pigs should have either ss to pasture, or generous quantities of ground alfalfa should ncorporated in their ration. Additional protein supplements ıld also be provided. The fiber content of roughages is too t and the stomach of the pig is too small to rely upon pas- s or ground alfalfa as the sole source of proteins. Except for ng pigs under 75 pounds in weight and gestating-lactating s, pastures or ground alfalfa may be satisfactorily balanced by protein supplements of plant origin—linseed meal, soybean l, etc. Soybeans and peanuts are satisfactory sources of plant eins, but when too large amounts are fed or when they are over a prolonged period of time, soft pork will be produced.

rgy Needs

Energy is first essential for the necessary life processes of animal. After these requirements are met, surplus energy be stored as body fat.

The chief sources of heat and energy in swine rations are carbohydrates and fats of available feeds. Protein-rich supple- ts seldom are used for this purpose because of their high and inefficiency when so used. Carbohydrates are the most ndant nutrients of all common feeds and are especially abund- in the cereal grains and their by-products. Fats, which are ndant in such common hog feeds as peanuts and soybeans, e an energy value about 2.25 times as great as carbohydrates proteins. It is to be emphasized, however, that liberal quan- s of either soybeans or peanuts will produce soft pork.

Because of the more restricted size of the digestive tract of s in comparison with that of ruminants, only limited quanti- of roughages are contained in normal swine rations. Rough- s (pastures or ground legume hays) are added to the ration use of their vitamins, minerals, and quality proteins, rather n for their energy purposes.

eral Needs

Of all common farm animals, the pig is most likely to suffer n mineral deficiencies. This is due to certain peculiarities of ne husbandry:

1. Hogs are fed principally upon cereal grains and their products, all of which are relatively low in mineral matter, icularly in calcium.

2. The skeleton of the pig supports greater weight in pro- ion to its size than that of any other farm animal.

3. As hogs do not consume any great amount of roughage (pasturage or dry forage), it is not always possible to balance mineral deficiencies.

4. Hogs grow more rapidly than other classes of livestock, and they produce young when less mature.

5. Hogs are forced for an early market, before they are mature.

MINERAL COMPOSITION OF THE PIG:

In order to understand the mineral needs of the pig, one should first consider the mineral elements of which the body is composed. The following are some estimates of the total quantities of the more common minerals found in the body of a 225-pound pig.[1]

TABLE 58

MINERAL ELEMENTS IN A 225-POUND PIG

Calcium	1.46 lbs.	Sodium	0.16 lbs.
Phosphorus	0.88 lbs.	Chlorine	0.13 lbs.
Potassium	0.34 lbs.	Magnesium	0.06 lbs.
Sulfur	0.20 lbs.	Iron	0.03 lbs.

In addition to the above, small quantities of copper, manganese, iodine, cobalt, and zinc are to be found—all in all, making a total of approximately 5 pounds of mineral or ash. Of this quantity, nearly 4 pounds are found in the skeleton, about 0.8 pound in the meat, about 0.2 pound in the organs including the alimentary tract, and slightly less than 0.1 pound each in the skin and blood.

CALCIUM AND PHOSPHORUS:

Swine are more likely to suffer from a lack of calcium than from any of the other minerals, except common salt. Swine are fed largely on cereal grains and their by-products, which are fair or even high in phosphorus. Consequently, a calcium deficiency is more likely in the ration than a phosphorus deficiency.

As has been shown in Table 58, these two minerals, calcium and phosphorus, make up about three-fourths of the mineral matter of the entire body and over 90 per cent of that in the skeleton. Since they form more than half the minerals in milk, their importance to the lactating sow is not to be overlooked. Liberal amounts of calcium and phosphorus are needed by the

[1] *Yearbook of Agriculture, 1939*, U. S. Dept. of Agri.

ying pigs, the pregnant sows (especially during the latter l of pregnancy), and by the sows when suckling a litter. The ortion of calcium to phosphorus is also important, especially n vitamin D is inadequate. From one and one-half to two s of calcium is needed to one part of phosphorus.

A deficiency of calcium and phosphorus (or a lack of vitamin etards normal skeletal development and gain in live weight. bones become fragile and are easily broken, and depraved tites may be observed. In brood sows, a pronounced lack of e minerals may prevent normal reproduction, and the young be born weak or even dead. If the deficiency persists with rickets will develop. This nutritional disease is characterized stiffness of the legs and a general unthriftiness; and it may result in a paralysis of the hind legs.

Feeding steamed bone meal, which furnishes both calcium phosphorus, is a common supplement when these two min- are needed for swine. When calcium alone is needed, ground stone or ground oyster shell flour may be used.

When the swine ration consists of a liberal allowance of al grains or their by-products (feeds rich in phosphorus)— g with a protein supplement of animal origin (tankage, fish , or milk by-products), feeds rich in calcium—usually no erals other than salt will be necessary. On the other hand, n protein supplements of plant origin (soybean oil meal, lin- oil meal, cull peas, etc.)—feeds poor in calcium—are used, very necessary that this mineral be provided. In general, n proteins of animal origin are used, adequate mineral pro- on can be obtained by simply allowing hogs free access to a compartment box with salt in one side and feeding steamed meal (or a mixture of ⅓ salt and ⅔ bone meal) in the r. In feeding proteins of plant origin, a third compartment aining ground limestone or oyster shell flour (or a mixture of third salt and two-thirds of the calcium supplement) may be added.

T:

Although swine require less salt than other classes of farm nals, it is generally advantageous to supply them with it, icularly if the protein supplement is not derived from tank- or fish meal (two feeds which supply salt). A lack of salt arked by poor appetite, unthrifty condition, and failure to v. Salt may either be added to the ration at the rate of ½ nd per 100 pounds of feed; or it may be provided in a suitable

box or trough to which the animals are allowed free access. When salt is fed free choice, pigs will consume from 0.03 to 0.12 ounce per head daily, the amount depending upon the size of the animal and the type of ration fed. When pigs are salt starved, precaution should be taken to prevent overeating salt. In iodine deficient areas, stabilized iodized salt should be used. In experiments at Purdue University,[1] conducted with growing-fattening pigs, it was found that 1 pound of salt costing less than 1 cent saved 287 pounds of feed worth $6.37. The pigs receiving no salt in the ration required 174 pounds more feed per 100 pounds of gain and gained only half as fast as the pigs given adequate salt.

IRON AND COPPER:

If suckling pigs are confined to paved pens or lots with no access to soil or forage (a common condition with pigs farrowed in the late winter or early spring months) serious losses from anemia (lack of red blood cells) are likely to be encountered. This anemia is due to a deficiency of iron and copper in the milk.

Nutritional anemia in swine, commonly called "thumps," is characterized by labored breathing, a swollen condition especially around the head and shoulders, and a general weakened condition. This deficiency disease may be prevented by giving the pigs access to a little uncontaminated soil or sod, free of worm infestation. In addition, the pigs should be encouraged to eat a grain ration as soon as they are old enough.

A common preventive measure or treatment for affected pigs consists of swabbing the udder of the sow with an iron sulfate solution [prepared by dissolving a pound of copperas (or ferrous sulfate), in a gallon of warm water]. This solution should be applied daily and may be put on the udder with a clean paint brush or a cloth swab. The iron solution contains enough copper as an impurity to supply the pigs' need for it.

FEEDS AS A SOURCE OF MINERALS:

The most satisfactory source of minerals for all livestock is in the feed consumed. It is important to know, however, whether the minerals in the ration are of the right kind and sufficient in amount. Certain general characteristics of feeds in regard to calcium and phosphorus (the two predominating mineral elements of the body) are worth noting:

1. The cereal grains and their by-products and protein supplements of plant origin are low in calcium but fairly high in phosphorus.

[1]Purdue University, Agricultural Expt. Sta. Mimeo. Circ. No. 18, 1934.

2. The protein supplements of animal origin (skim milk, ermilk, tankage, meat scraps, fish meal), legume forage (pas-ge and hay), and rape all are rich in calcium.

3. Most all protein-rich supplements are high in phosphorus.

With the possible exception of common salt, the mineral irements of swine can often be met through the proper selec- of feeds. This may not hold true, however, in feeding young and gestating-lactating sows.

THOD OF FEEDING THE MINERAL SUPPLEMENT:

It is preferable to allow the hogs free access to minerals by iding them in a suitable box or self-feeder, with each mineral separate compartment.[1] The particular needs of the animals guide them in consuming sufficient of the minerals to correct deficiency of the ration. If the mineral supplement is incor-ted in the grain ration, usually 1 per cent by weight will e adequate; whereas if it is incorporated in the protein con-rate, about 5 to 6 pounds of mineral mixture should be added ch 94 to 95 pounds of high-protein feed.

min Needs

Because of the greater prevalence of dry-lot feeding, swine more likely to suffer from nutritional deficiencies, especially of vitamins, than any other class of farm animals. The vita- requirements are especially important in young pigs (from n to 75 pounds) and in gestating-lactating sows.

AMIN A:

Either the plant form (carotene or provitamin A) or the nal form (true vitamin A) can serve as a source of this factor swine. It must be emphasized, however, that tankage and t scraps have little vitamin A potency. Fish meal, likewise, variable and undependable source. Once the fat has been re-ed, milk by-products are low in vitamin A. Thus, under prac- conditions, the pig is pretty well limited to plant sources of min A. The best practical plant sources of carotene for swine ude green pastures and hays, yellow corn, and green or yel-peas.

The winter period is the most critical time for swine feeding, over much of the United States this necessitates dry-lot feed- Dry-lot and winter swine rations should contain a quantity

[1] Instead of feeding each mineral separately, generally a mixture of hird salt to two-thirds of each mineral is used to secure greater ability. In addition, salt (or iodized salt, in iodine-deficient areas) is ded in a separate compartment or box.

of well-cured, leafy, green alfalfa hay—5 to 10 per cent for growing-fattening pigs and 15 to 35 per cent for brood sows. Green pastures are always an excellent source of carotene.

In the absence of green forages, in periods of drought, and in various parts of the world where pig diets consist of materials low in carotene—such as white corn, barley, wheat, oats, rye, and feeds made from the by-products of these grains—serious vitamin A losses have occurred.

VITAMIN D:

A lack of vitamin D (or of calcium or phosphorus) in swine rations will cause rickets in young pigs or osteomalacia in mature hogs. Both conditions result in large joints and weak bones.

In the northern latitudes, a combination of limited and none too effective sunlight and limited quantities of sun-cured hay in the ration cannot always be relied upon to supply ample quantities of vitamin D to hogs. Under these conditions, the addition of ¼ to ½ pound of irradiated yeast, costing 10 to 30 cents, to each ton of feed is cheap and effective protection. It is also to be emphasized that the vitamin-D requirement is less when a proper balance of calcium and phosphorus exists in the ration.

THE B VITAMINS:

As indicated in the Animal Vitamin Chart, Table 8, the farmer under ordinary circumstances can meet the B (or B-complex) vitamin requirements of the pig by following enlightened feeding practices. For the most part, this includes the maximum use of pastures throughout the grazing season and the feeding of generous quantities of well-cured, green, leafy alfalfa meal during the winter months or under dry-lot conditions. On the other hand, young growing pigs or gestating-lactating sows may not secure optimum amounts of certain of these factors, particularly under dry-lot conditions. It is considered good practice, therefore, to include animal proteins in swine rations during these critical periods.

Experimental work has indicated that the following members of the B-complex are required by the pig: thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, choline, biotin, folic acid, and B_{12}. Of these, it appears that riboflavin, niacin, choline pantothenic acid, and B_{12} are probably the most limiting for swine during growth and reproduction.

At the Washington Agricultural Experiment Stations, no beneficial effect on growth or efficiency of feed utilization was

ined when inositol, biotin, or para-aminobenzoic acid were ed to a basal ration which contained the six B vitamins—mine, riboflavin, niacin, pyridoxine, pantothenic acid, and ine. Folic acid was shown to be needed by the pig for maxi-n hemoglobin formation. This would indicate that either there ufficient intestinal synthesis of these vitamins or that the does not need them. Also, at the Washington Agricultural eriment Stations, the deletion of either thiamine, riboflavin, ine, or folic acid from the ration of sows resulted in unsatis-ory reproduction and lactation.

KNOWN FACTOR OR FACTORS:

Optimum results with swine during the critical periods ly growth and gestation-lactation) appear to be dependent providing B_{12}, and perhaps unknown factors, through feed-some protein supplements of animal origin (fish meals, tank-meat meal, liver, and/or dried milk). Also, green pastures; -cured, green leafy alfalfa hay or distillers solubles. These s appear to possess certain valuable properties for swine, aps including an unknown factor or factors.

OY STORAGE:

Work at both the Wisconsin and Washington stations has vn that the ration gilts receive during growth influences r performance during reproduction three to five months later. s means that growing gilts, provided that they are fed a -balanced ration which supplies these factors, store up certain hese factors which are later required in reproduction. This nomenon is referred to as the residual effects of previous rition. This means that the ration of prospective breeding s should receive more attention than may be necessary to give he ration of growing-fattening hogs to be placed on the ket.

Work at the Washington Agricultural Experiment Stations also shown a positive relationship between thiamine intake the deposition of this vitamin in the tissues of hogs. It was d that one pork chop from the pigs consuming the thiamine-ched ration contained sufficient of this factor to meet the y requirements of a human. However, it would have required pork chops from the pigs on a low-thiamine ration to meet same need. This suggests the possibility of increasing the ritive qualities of pork through the ration.

SUMMARY OF VITAMIN NEEDS OF SWINE:

In summary, it may be stated that the maximum year-round use of either green pastures or well-cured, green, leafy alfalfa hay will eliminate most of the vitamin deficiencies of swine under practical farm conditions. A possible exception may exist in the case of young pigs and gestating-lactating sows, critical periods during which it is considered good practice to include some animal proteins in the ration.

The crop rotation should be designed to provide for a long pasture season, and ground alfalfa should be available for the rest of the year. When pastures are not available, the ration of growing-fattening pigs should contain 5 to 10 per cent ground alfalfa and that of brood sows from 15 to 35 per cent alfalfa. Lush pasture grasses and bright green alfalfa hay are unexcelled as sources of carotene (provitamin A) for swine. Likewise, the exposure of the ergosterol of grasses or hay to direct sunlight causes it to serve as an excellent precursor for vitamin D. When pigs graze pastures, the direct exposure of the animal to the sunlight also results in the formation of vitamin D from the cholesterol of the skin.

Green grasses and hays are also excellent sources of the B vitamins and the unknown factor(s).

When neither pastures nor alfalfa hay are available, the essential B vitamins for the pig may be provided by adding to the ration 2 to 4 per cent of yeast, distillers' dried grains with solubles, distillers' dried solubles, or other fermentation by-products. The only limiting factor in the use of these concentrates is their high price. Fish meal and *good quality* tankage are also satisfactory sources of most of these vitamins.

Water Needs

The daily water requirements of swine vary from $\frac{1}{2}$ gallon to $1\frac{1}{2}$ gallons per 100 pounds live weight. The higher requirements are for young pigs and lactating sows. It is preferable that swine have access to automatic waterers, with water available at all times. Otherwise they should be hand watered at least twice daily.

If swine get an abundance of such watery feeds as dairy by-products or slop, there will be less need of furnishing water separately. On the other hand, when self-fed dry feeds, pigs need access to good fresh water at all times. Otherwise feed consumption will be too low for satisfactory performance.

DS FOR SWINE

Throughout the world, swine are raised on a great variety eeds, including numerous by-products. Except when on ure or when ground dry forages are incorporated in the ra- they eat relatively little roughage.

In this country, corn and swine production have always been ly associated. Normally, more than one-half of the corn crop d to hogs. Yet, the agriculture of the forty-eight states is diverse, and the diet of the pig is readily adapted to the s produced locally. A similar adaptation in feeding practices und in other countries. Thus in most sections of the world, e are fed predominantly on home-grown feeds. Ireland de- s largely upon potatoes and dairy by-products; the swine stry of Denmark has been built up to augment the dairy stry, with milk and whey supplementing home-grown and rted cereals; and in Germany, the pig is fed on such crops otatoes, sugar beets, and green forage.



ig. 310. Corn is the chief concentrate fed to swine in the United States. ally, one-half of corn crop is fed to hogs. Shown are 194 spring pigs g ear corn on the farm of W. J. Sweeney, Cherokee County, Iowa. tesy, Wallace's Farmer and Iowa Homestead.)

entrates For Swine

Because of their simple monogastric stomach, swine consume e concentrates and less roughages than any other class of animals. This characteristic gives the pigs less opportunity nsume large quantities of calcium and vitamin-rich and r quality protein roughages. Also swine grow more rapidly

than cattle, sheep, or horses, and produce young when less mature. This combination of conditions results in swine suffering more nutritional deficiencies than other large animals. It is probably safe to assume that less than half of the swine in the United States are fed balanced rations; yet, with our present knowledge of nutrition, this need not be so.

Although most concentrate feeds are not suitable as the sole ration for hogs, it must be realized that swine can utilize a larger variety of feeds to greater advantage than any other farm animals. In general, the grain crops—corn, barley, wheat, oats, rye, and the kafirs—constitute the major component of the swine ration. However, sweet potatoes and peanuts are successfully and extensively used in the South, soybeans in the central states, and peas in the Northwest. In those districts where they are grown, potatoes also are usually utilized in considerable quantities in feeding hogs. In addition, in most every section of the country one or more by-product feeds are fed to hogs—including the by-products of the fishing industry, the meat packing industry, the milling industry, and the dairy industry. Human food wastes, such as refuse or garbage, are also fed extensively.

It is estimated that the concentrates—including the grains, root crops, and by-product feeds—make up on the average from 75 to 95 per cent of the ration of hogs, with the rations of growing-fattening pigs holding to the upper limits. Thus, normally, only limited high-quality roughages or superior pastures are included in the ration of the pig.

The protein and vitamin requirements of the monogastric pig differ very greatly from those of the ruminant; for the latter improves the quality of proteins and creates certain vitamins through bacterial synthesis.

Despite all this, it is possible to meet the nutritive needs of the pig on these concentrated feeds by keeping in mind the following factors when balancing the ration:

1. The cereal grains and their by-products are relatively good in phosphorus, but low in calcium and the other minerals.

2. Except for the carotene content of yellow corn and green peas, the grains are very poor sources of the vitamins.

3. The cereal grains supply proteins of poor quality.

4. Protein supplements of animal origin generally supply proteins of high quality, whereas proteins of plant origin supply proteins of low quality.



ig. 311. Pigs on alfalfa pasture. Superior pastures reduce the cost of tion, provide a good source of calcium, serve as an excellent source of of the needed vitamins, and furnish higher quality and quantity pro- han the grains. (From *Pork Production*, Copyright 1937, by Prof. W. ith, Purdue University, through the courtesy of the author and The illan Company.)

5. Because of the inadequacies of most concentrates, it is ly necessary to rely on green pastures or high-quality, green, alfalfa for the needed vitamins in practical swine rations. fa is also a good source of calcium.

ures For Swine

Although swine cannot be grown and fattened economically asture crops alone, these crops are an important adjunct to od grain ration. Green, succulent pastures are also superior mparable quality dry roughages for swine and should be ded whenever possible. In addition to reducing the cost of ration, superior pastures, especially if legumes, provide a source of calcium, serve as an excellent source of most of needed vitamins, are higher in protein content than the s, and carry protein of better quality than is found in grains.

In general, temporary pastures are preferable to permanent ures for swine, especially from the standpoint of disease and site control. But permanent pastures do have a very definite in the swine program. Although no single pasture crop can ecommended as being best for any and all conditions, there ertain desirable qualities that should be considered in choos- forage crop for swine. Some of these characteristics are as ws:

1. Adaptation to local soil and climatic conditions.

2. Ability to produce a high yield of palatable, succulent, highly nutritious forage.

3. Length of grazing season; with nearly year-round grazing if possible.

4. Ability to endure tramping and grazing.

5. Cost and ease of seeding.

Although it is recognized that no single pasture crop meets all of these characteristics in a faultless manner, the crops of greatest value are those which most nearly meet them. Over much of the country, most of these essential qualities are possessed by alfalfa, the clovers (principally ladino, red, alsike, and sweetclover), rape, and oat mixtures. Other plants which find use as hog pastures in certain areas and under certain conditions are bluegrass, orchard grass, lespedeza, carpet grass, rye, wheat, soybeans, cowpeas, field beans, sorghum, and Sudan grass. As there are so many different factors to consider in planning a pasture crop-rotation for hogs, it is recommended that the individual producer consult his local county extension agent, F.F.A. instructor, or state agricultural college.

Good pastures have definitely established their worth in a successful swine enterprise. Some of the advantages of pastures may be summarized as follows:

1. Pigs fed on pasture require less grain than pigs fed in the dry lot. Naturally, this becomes a most important consideration during those times when grain prices are high. The grain saving affected through the utilization of pasture has been found to vary from 12 to 15 per cent when full and balanced rations are fed to as high as 50 per cent when the ration is not well balanced.

2. Pastures furnish a convenient and economical way to compensate for the protein, mineral, and vitamin deficiencies of the cereal grains. This does not infer that protein and mineral supplements should not be supplied in addition.

3. Smaller quantities of protein-rich feeds are needed to balance the ration when pigs are fed on pasture. When on full feed, pigs grazed on a good legume pasture require only approximately half as much concentrated protein supplement as pigs in dry lot. As protein supplements frequently have to be purchased at a high cost, this may be a most important consideration for the success of the swine enterprise.

4. Pigs on forage crops usually make more rapid gains.

5. Swine kept on pastures are more thrifty and healthy. may be attributed to the green, succulent feed; the proper ce of nutrients, the exercise; and the more sanitary condi- that usually accompany such a system of care and manage- particularly if pastures are rotated. As a result, less trou- with diseases and parasites are encountered.

6. The maximum fertility value of the manure is conserved.

7. Less labor is required—chiefly because the hogs gather t of their feed, and less labor is required in keeping their undings clean and sanitary.

8. Limited feeding can be practiced to better advantage pigs on forage. This may be an important consideration the producer is gambling on a higher market at a later or when feed is high or scarce and it is desired to carry the until the new crop is available.

9. When superior pastures are available, swine seldom suffer any vitamin deficiencies, and protein and mineral deficien- are minimized.

When hogs are fattened on pasture, either of the following ms may be employed: (1) limited grain allowance during asture season, or (2) full feeding during the entire pasture d. The particular system decided upon will for the most part d upon the relative price of grain and pasture and the time ich it is desired to market. Full-fed pigs usually reach an r and better market and bring returns more quickly. On the hand, limited feeding usually requires less protein supple- and less cereal grain. In any event, it must be remembered pastures, good as they may be, are always roughages and concentrates.

Pastures are especially important for the gestating-lactating sow and for young pigs. At no other stage in the life of ig are the nutritive requirements so critical. Fortunately, combined with the natural feeds common to the area, pas- meet these needs admirably.

Roughages For Swine

During the winter months or at other seasons of the year green, succulent pastures cannot be provided, it is very ssary that swine rations contain generous quantities of a quality ground forage, preferably alfalfa. Well-cured, green,

leafy alfalfa will supply the body-building minerals, vitamins, and quality proteins that are lacking in most farm grains.

Nutritionists generally look upon alfalfa as holding a place in animal nutrition comparable to that which milk popularly holds in human nutrition. Alfalfa contains proteins of the right quality to balance out the amino-acid deficiencies of grain proteins; it is a rich source of minerals, especially calcium; and, finally, it is an excellent source of all the vitamins needed by the pig. From the standpoint of vitamins alone, alfalfa is almost indispensable in dry-lot swine rations. If leafy and green, it is high in carotene (provitamin A), a lack of which results in poor growth and the farrowing of premature, dead, or weak pigs. Sun-cured hay is also a good source of vitamin D, the anti-rachitic vitamin. In the northern latitudes in particular, the pig may have to obtain dietary sources of vitamin D, for the action of the sun's ray on the body of the animal may prove inadequate. Alfalfa is also an excellent source of the long list of B vitamins.

Because of the many virtues of well-cured, green, leafy alfalfa in the swine ration, it is generally recommended that gestating-lactating sow rations contain from 15 to 35 per cent ground alfalfa. Because of the more limited digestive capacity of swine and their inability to utilize fiber, the alfalfa content of the ration for growing pigs must be more restricted. Thus the alfalfa content of the ration of growing-fattening pigs had best be held to a level of 5 to 10 per cent.

In addition to its beneficial effects in supplying the needed vitamins, minerals and proteins, the inclusion of alfalfa in swine rations generally reduces the feed cost, for alfalfa seldom costs as much per pound as the grains.

Hogging Down Crops

The practice of allowing pigs to do their own harvesting is followed quite generally in many sections of the United States. Corn is the principal crop so used, the animals being turned into the field when the grain is in the dent stage. Sometimes small grain crops that have been badly lodged or otherwise damaged are harvested by hogs. Soybeans and field peas also are frequently hogged off. In the South, such crops as peanuts, sweet potatoes, chufas, and other root and tuber crops are often harvested by hogs.

Space will not permit a full discussion of this method of ing the various crops. As corn is the main feed hogged down, nents will be limited to this crop; but it will be understood the same general principles apply to the other crops, when f they are so utilized.



g. 312. Hogging down corn. The animals are usually turned into the hen the grain is in the dent stage. This practice saves labor, con- maximum fertility value of the manure, and lessens disease and para- oubles. (From *Pork Production*, Copyright 1937 by Prof. W. W. Smith, e University, through the courtesy of the author and The Macmillan any.)

ANTAGES OF HOGGING DOWN CORN:

Some of the advantages of this practice are as follows:

1. It saves labor at a busy season of the year.
2. The maximum fertility value of the manure is conserved.
3. There is less danger of infesting swine with diseases parasites than in dry-lot fattening.
4. Corn or other crops that are down or badly lodged are ult to harvest, but they may be utilized through hogging .

DVANTAGES OF HOGGING DOWN CORN:

Some of the disadvantages of hogging down corn may be erated as follows:

1. During wet weather, a considerable amount of corn is by being tramped into the ground.

2. During wet weather, the tramping of animals puddles the soil and lowers its tilth. This is especially noticeable in heavy clay soils.

3. It usually requires additional fencing.

4. Early pigs cannot be used in hogging down corn, for they will be too far advanced.

5. Pigs used in hogging down corn are usually finished at a season of the year when prices are low.

6. When corn is hogged down, wheat cannot follow corn in the rotation.



Fig. 313. Hogging down wheat. Sometimes small grains that have been badly lodged or otherwise damaged are harvested by hogs. (From *Pork Production*, Copyright 1937 by Prof. W. W. Smith, Purdue University, through the courtesy of the author and The Macmillan Company.)

SOME ADDITIONAL FACTS ABOUT HOGGING DOWN CORN:

1. *Economy.*—Numerous experiments have been conducted for the purpose of determining the economy of hogging down corn. Although the results have been varied, there appears to be little difference between yard-feeding and hogging down corn except when a wet season is encountered.

2. *Supplemental forage with corn.*—Experiments and practical feeding operations show that it is generally advantageous to grow some supplemental crop with the corn even though the yield of corn is reduced slightly. Soybeans and rape are most commonly grown in the Corn Belt. A leguminous pasture adjacent to the corn will serve the same purpose.

3. *Protein supplement.*—When there is an abundance of soybeans or rape in the corn, it may not be economical to include

otein supplement when such feed is high in price. In general, ever, a protein of animal origin (tankage, fish meal, etc.), ld be fed at the rate of .2 to .4 pounds per head daily. The t amount will depend on the age of the pigs and the quantity pplemental forage available.

4. *Weight of pigs.*—Late spring pigs that are in feeder ition and weigh 80 to 125 pounds are ideal for hogging down . Except for gleaning the fields, breeding animals should not urned into the field; for they will become too fat.

5. *State of maturity.*—Usually, hogs should not be turned the corn before it is well dented. When feed is scarce or



Fig. 314. Hogging off peanuts and sorghums. In the South, such crops eanuts, sweet potatoes, chufas, and other root and tuber crops are harvested by hogs. (Courtesy, National Cottonseed Products Asso-n, Inc.)

n it seems desirable for other reasons, hogs may be turned a field of standing corn any time after the dough stage. nals should be started on the new feed gradually in order void digestive disturbances.

6. *Size of area.*—It is usually recommended that the area ed off be no larger than can be hogged off in two to three ks. A temporary fence can be constructed with 26-inch woven anchored well with solid end posts. Between the end posts fence may be wired to corn stalks and an occasional driven . The carrying capacity of a given area will vary with the l of corn, size of pigs, and available supplemental feeds.

7. *Finishing period.*—It is usually best to finish the animals by yard feeding during the last thirty days. Brood sows and young pigs can be used to glean the fields.

Garbage For Swine

Municipal garbage has long been fed to fattening hogs; but during the past two decades, the practice has declined because of a gradual lowering in the feeding value of garbage and other competition for garbage—notably its manufacture into lawn, greenhouse, and garden fertilizer.

Twenty years ago, the garbage feeder calculated that a ton of city garbage would produce 60 to 100 pounds of pork; whereas, at the present time, it is estimated that a similar quantity will not produce more than 30 pounds of pork. The change in feeding value may be largely attributed to improved refrigeration and the effective use of "left-overs." Institutional, hotel, and restaurant garbage is superior to household garbage.

Garbage may be utilized either as a feed for a sow and pig enterprise or for fattening out feeder pigs that are secured from other sources. Usually, the venture seems most successful when a combination of grain and garbage feeding is practiced.

It is also observed that the most successful garbage feeders use concrete feeding floors, practice rigid sanitation, and take every precaution to prevent diseases and parasites. Unless considerable grain is fed to market hogs, especially after weights are over one hundred pounds, soft pork and paunchiness will result in garbage-fed hogs.

Raw garbage has a higher feeding value than cooked garbage. Cooking allows for less feed selection on the part of the pig and lowers the digestibility of some of the nutrients, especially the proteins. On the other hand, swine are more likely to become infested with trichinella when fed on raw garbage. The claim is frequently made that the greatest number of cases of trichinosis in humans occurs in communities where garbage is fed to hogs. It should be understood, however, that there is little or no danger in transmitting the disease in this way provided the pork and pork products are thoroughly cooked. Frozen garbage should be thawed before feeding.

FEEDING GROWING-FATTENING PIGS

In the practical swine enterprise, "growing-fattening" generally refers to that period from weaning (about eight weeks of age) to market weight of about 225 pounds. Because hogs are

ened at an early age, the process really consists of both grow- and fattening. In a general way, there are two methods of shing hogs for market: (1) full feeding all the time until the nals attain a market weight and (2) limited feeding early in period, with full feeding the last sixty to seventy-five days he period before marketing. Pasture may be utilized to advan- e with both methods. But as would be expected, greater use forage crops will accompany a system of limited rations. ther system, full feeding or limited feeding, can be recom- ded as being best for any and all conditions. The plan to w should be determined by: (1) market conditions, (2) price eeds, (3) feeds available on the farm, (4) kind and extent of tures available, (5) available labor, etc. Self-feeders are well pted to a system of full feeding, but hand feeding is necessary ny plan for limiting the ration. In general, when confined to dry lot, growing-fattening pigs should be full fed, and the on should contain 5 to 10 per cent of a ground dry forage, ferably high quality alfalfa.

When on full feed, fattening pigs will consume approximately ounds of feed daily per 100 pounds live weight up to 100 nds in weight. From 100 pounds to a finished weight of 225 nds, pigs on full feed consume about 4 pounds of feed daily each 100 pounds of live weight. On the average, about 400 nds of feed are required to produce 100 pounds of gain during growing-fattening period, but the amount varies with the erent ability of the animals, thrift, and the kind and amount asture utilized. About 360 pounds of this feed is grain and 40 nds protein supplement. Of course, the feed consumption of breeding herd and that of the pigs during the suckling period st be added in order to arrive at the total feed requirements. t accounting studies on Corn Belt farms show that approx- tely 500 pounds of feeds are consumed per 100 pounds of hogs rketed.

The protein requirements of the pig are greatest early in . For this reason, decreasing percentages of protein supple- nt should be incorporated in mixed rations as the fattening cess progresses. If the ration is self-fed cafeteria style, the s generally will automatically balance out these needs. In any nt, however, ample protein should always be provided in the ion, otherwise growth will be retarded. It is also important t the mineral and vitamin needs of growing-fattening pigs met.

As previously indicated, pigs can utilize a great variety of concentrates. The chief ingredients of a growing-fattening ration, therefore, are usually, for practical reasons, those most readily available at the lowest possible price. In most cases, only the protein supplement is not home grown.

FEEDING PROSPECTIVE BREEDING GILTS AND BOARS

For best results, prospective breeding gilts should be fed differently from growing-fattening hogs. For the ration fed during growth, from weaning to breeding age, affects the results obtained many months later in conception, reproduction, and lactation. Experimental evidence indicates that there is storage of factors during growth and that these factors are later of considerable importance. The same condition applies to prospective herd boars.

In view of this situation, it is usually important that prospective breeding animals, both gilts and boars, should be fed separately and apart from fattening hogs. In the first place, it is neither necessary nor desirable that breeding animals become so fat as pigs that are being finished for market. Rather, size, growthiness, thrift, and good bone is desired. To this end, it is essential that the ration contain sufficient proteins and proteins of good quality and that there be an abundance of the essential minerals and vitamins. These nutrients are best assured if future breeding animals are kept on year-round pasture as much as possible and if, when pasture is not available, 10 to 15 per cent of a high quality legume hay is incorporated in the ration.

Provided that good pastures are available or a generous allowance of a high quality legume is incorporated in the ration, the kind of concentrates (grain and protein supplements) fed to prospective breeding gilts or boars is relatively unimportant. When such forages are not available or are limited, however, a part of the protein supplement should always be of animal origin —dairy by-products, tankage, or fish meal. If the animals are inclined to get too fat, which is likely to happen in self-feeding, the ration may well contain considerable bulky feeds, such as ground oats or wheat bran.

FEEDING THE HERD BOARS

The feed requirements of the herd boar are about the same as those of a sow of equal weight. He should always be kept in thrifty, vigorous condition and virile. To this end, feed and exercise are important. Year-round succulent pasture is excellent

m the standpoint of providing both needed exercise and valu-
e nutrients. In winter, the boar should still be allowed the run
a paddock of sufficient size so that he will get abundant exer-
e, and 15 to 35 per cent of a high quality ground legume should
incorporated in a well-balanced ration.

In no cases should herd boars be overfat, nor should they be
a thin run-down condition. Except during the breeding season,
ut 1 pound of concentrates daily per 100 pounds live weight
sufficient for mature boars on good pasture. A more liberal
ion must be provided in the winter time and when the sire
n heavy service. The feed allowance should be varied with the
, development, temperament, breeding demands, and roughage
sumed.

EDING THE BROOD SOWS

The gestation-lactation period is a critical one in swine nutri-
n. It is now known that the feed and care accorded the brood
v materially affects conception, reproduction, and lactation.
e basis for successful and practical feeding of the brood sow
sists of making the maximum use of pastures and of feeding
generous quantity of ground legumes during those periods
en pastures are not available. Such roughages enhance the
ion through increasing the quantity and improving the quality
the proteins, providing the necessary vitamins, and improving
mineral content of the ration.

ushing The Sows

The practice of conditioning or having the sows gain in
ight just prior to breeding is known as "flushing." A great
riety of feeds may be used satsifactorily for bringing about
e condition of breeding thrift sought at this time. From a prac-
al standpoint, it is usually best to use a home-produced grain
ion together with pasture in season or a legume hay during
winter months. For young growing animals or when non-
ume pastures are being used, it is important that a protein
pplement be added to the ration. In addition to providing suit-
le feeds for flushing, it is important that one feed the sows a
ion adequate to produce gain in weight at the rate of 1 to 1½
nds daily.

e Gestation Period

The nutrients of the pregnant sow must first take care of
usual maintenance needs. If the gilt is not fully mature,
trients are required for maternal growth as well as for growth

of the fetus. Quality and quantity of proteins, minerals, and vitamins become particularly important in the ration of young pregnant gilts; for their requirements are much greater and more exacting than those of the mature sow.

Approximately two-thirds of the growth of the fetus is made during the last month of the gestation period. It may be said, therefore, that the demands resulting from pregnancy are particularly accelerated during the latter third of the gestation period. Again, the increased needs are primarily for proteins, vitamins, and minerals.

During gestation, it is also necessary that body reserves be stored up for subsequent use during lactation. With a large litter and a sow that is a heavy milker, the demands for milk production are generally greater than can be supplied by the ration fed at the time of lactation. Although desired gains will vary somewhat with the initial condition, mature sows are generally fed to gain 75 to 85 pounds during the pregnancy period, and pregnant growing gilts should gain slightly more.

There is no better place for pregnant sows than in a leguminous pasture. Luxuriant pasture of this type is particularly valuable in supplementing the grain ration with minerals, vitamins, and quality proteins. Aside from supplying the necessary nutrients at a low cost, this system provides much valuable exercise.

With reference to the quality of proteins, minerals, and vitamins in the winter ration, it is the feeling of most good swine producers that these needs can be met most easily and cheaply through adding 15 to 35 per cent of a high quality ground alfalfa to the ration. At least a part of the proteins supplied during the gestation period should be of animal origin (tankage, fish meal, skim milk, etc.). It also is good and cheap protection to allow the sows free access to a three-compartment mineral box, with salt (iodized salt in iodine-deficient areas) in one compartment, feeding steamed bone meal in another, and oyster shell flour or limestone in the third.

Farrowing Time

It is considered good practice to feed lightly and with bulky laxative feeds immediately before and after farrowing. Wheat bran or oats may constitute half of the limited ration, and a small amount of linseed oil meal may be added. From ten days to two weeks is the usual time suggested in getting the sow back on full feed after farrowing.

The sow may be watered at frequent intervals before or r farrowing, but in no event should she be allowed to gorge. s also a good plan to take the chill off the water in the winter- e.

Lactating Period

The nutritive requirements of a lactating sow are more rous than those during gestation. They are very similar to se of a milk cow, except in that they are more exacting rela- to quality proteins and the B vitamins because of the absence umen synthesis in the pig. It is estimated that a sow will duce from 1½ to 1½ gallons of milk daily. A sow's milk is also ier than cow's milk in all nutrients, especially in fat. Thus s suckling litters need a liberal allowance of concentrates in protein, calcium, phosphorus, and vitamins. To supply se needs, one should provide (1) a well-balanced ration con- ing one or more protein supplements of animal origin, and either access to a succulent pasture or to a ration containing o 35 per cent of a good quality ground legume. There should be free access to salt, bone meal, and limestone or oyster ll flour.

It is essential that suckling pigs receive a generous supply milk, for at no other stage in life will they make such econom- gains. The gains made by pigs from birth to weaning are gely determined by the milk production of the sows; and this turn is dependent upon the ration fed and the inherent ability produce milk. The lactating sow should be provided with a eral feed allowance—ranging from 2½ to 4½ pounds daily for h 100 pounds weight. Generous feeding during lactation, with mall shrinkage in weight, is more economical than a stingy wance of feed.

E CORN-HOG RATIO

The corn-hog ratio refers to the number of bushels of corn quired to equal in value 100 pounds of live hog. Thus, a corn- g ratio of 11 means that price relationships are such that 11 shels of corn equals in value 100 pounds of hogs. Usually the ures are computed on the basis of some central market, but m prices may be used. A corn-hog ratio of 11.4 is accepted as rmal; this figure is based on the average price relationship r the period 1910 to 1914.

A high corn-hog ratio, one which is above 11.4, means cheap rn and high-priced hogs and likely profit to the producer—

conditions that stimulate more breeding and feeding to heavier weights. On the other hand, a low ratio, one which is below 11.4, means high-priced corn and low-priced hogs—conditions that result in less breeding and feeding of swine.

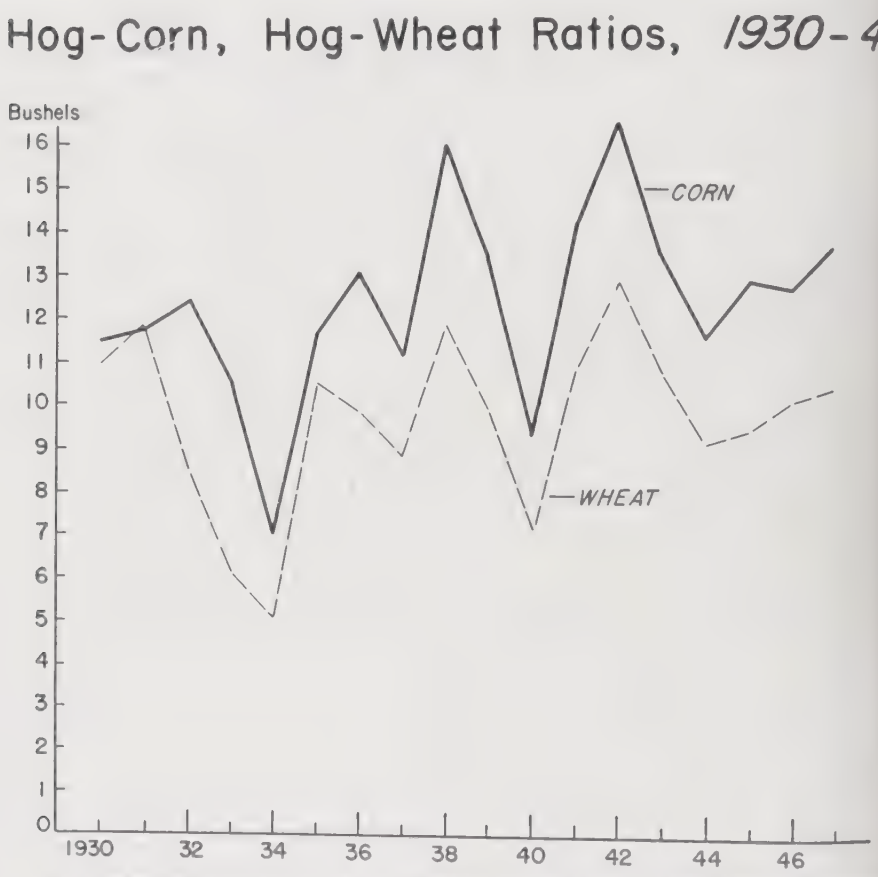


Fig. 315. The corn-hog and wheat-hog ratios, 1930-1947. A corn-hog ratio of 11.4 is accepted as normal, with a higher figure than this favorable to the producer and a lower figure unfavorable to the producer. Note that the wheat-hog ratio closely parallels the corn-hog ratio, though consistently it is a lower figure. (Based on U.S.D.A. data.)

SOFT PORK

Feed fats are laid down in the body without undergoing much change. Thus, when fattening hogs are liberally fed on high-fat content feeds in which the fat is liquid at ordinary temperatures, soft pork results. This condition prevails when hogs are liberally fed such feeds as soybeans, peanuts, mast, or garbage. The fat of the cereal grains is also liquid at ordinary temperatures, but fortunately the fat content in these feeds is relatively low. When such feeds are liberally fed to swine, most

e pork fat is actually formed from the more abundant car-
drates in these feeds.

Soft pork is undesirable from the standpoint of both the
ssor and the consumer. It remains flabby and oily even under
geration. In soft pork, there is a higher shrinkage in process-
the cuts do not stand up and are unattractive in the show
it is difficult to slice the bacon; and the cooking losses are
r through loss of fat. For these reasons, hogs that are
lly fed on those feeds known to produce soft pork are
ly discounted on the market.



ig. 316. Soft pork. Feed fats do affect body fats. The bacon belly on
ft came from a hog liberally fed on soybeans. Soft pork is undesirable
se it shrinks excessively; it is unattractive in the show case; it is
lt to slice; and it suffers heavy cooking losses of fats. (Courtesy, Prof.
r Bull, University of Illinois.)

The firmness of pork carcasses may be judged by: (1) grasp-
he flank below the ham, (2) lifting one end of the cut while
itting the other end to rest on the table (a firm pork cut
not bend readily), or (3) applying a slight pressure of the
nb (not gouging) on a cut surface. Experimentally, the iodine
ber is used in determining the degree of softness; this is a
sure of the degree of unsaturation.

Unless the producer is willing to take the normal reduction
rice (about $1.00 per hundredweight), it is recommended
feeds which normally produce soft pork be liberally fed only
gs under 85 pounds in weight and to the breeding herd. For
ing-fattening pigs over 85 pounds in weight, soybeans and
uts should not constitute more than 10 per cent of the ration
serious soft-pork problem is to be averted.

Experimental evidence and practical observation have shown, however, that when a ration producing hard fat is given following a period on feeds rich in unsaturated fats, the body fat gradually becomes harder. It has also been found that this process takes place more rapidly if the animals are first fasted for a period before the change in ration is made. This practice is called "hardening off." Thus many hogs that are, for practical reasons, fattened primarily on such feeds as soybeans, peanuts, or garbage are "hardened off" with a ration of corn or some other suitable grain.

FEED ALLOWANCE AND SOME SUGGESTED RATIONS FOR SWINE[1]

Hogs can and do use many different concentrates. That makes it possible to choose as chief ingredients those most readily available at the lowest price. Usually, farmers grow their own grains and buy the protein supplements.

Other factors being equal, a variety of feeds is preferable. Although the choice of ingredients will and should vary from area to area, and even on adjoining farms, the rations in tables 59, 60, 61, and 62 will serve as useful guides.

In formulating these rations, it was recognized that gestation, lactation, and growth up to 75 pounds in weight in dry-lot feeding constitute the most critical periods, nutritionally, in the life of the pig. Accordingly, in the suggested rations, a considerable margin of safety is provided over and above the minimum protein requirements during these periods.

[1]Grateful acknowledgment is given of the able assistance of three of the author's WSC colleagues in the preparation of this section, especially the suggested rations. Mr. James Nofziger computed each ration and Dr. Burch H. Schneider and Mr. Charles Kyd made many helpful suggestions and criticisms. Where possible these rations were computed from the requirements as reported by the National Research Council and interpreted by the author.

TABLE 59

NDY GESTATING-SOW FEEDING GUIDE: FOR ALL AGES (1) IN DRY LOT, AND (2) ON PASTURES[1]

(These rations are equally satisfactory for replacement gilts and herd boars)[2]

Ingredients	For Sows in Dry Lot		For Sows On Pasture
	Ration No. 1, lbs.	Ration No. 2, lbs.	Ration No. 3, lbs.
d corn, wheat, barley, and/or sorghum	75	60	90
a meal	15	30	
al protein supplement ge, meat meal, fish meal, r dried milk)	6	5	5[3]
protein supplement (soy- cottonseed, linseed, and/ nut meal)	4	5	5[3]

Gestating sows are generally hand-fed to limit feed intake. This s (1) excess fatness and (2) unnecessary feed expense. However, nay be self-fed if more bulk is added to the ration. Bulk may be pro- by (1) using considerable oats, and (2) adding 25 per cent or more ound alfalfa to the ration.

With mature pregnant sows, it is usually desirable to limit concen- consumption to about 1½ pounds daily per 100 pounds live weight. replacement pregnant *gilts*, concentrate consumption should be at the of about 2 pounds daily per 100 pounds live weight. Sufficient ground and ground alfalfa—two bulky feeds—may be added to the ration to feed consumption to these figures.

ation 1, above, is suitable for hand-feeding. Ration 2 is suitable for eeding. Ration 3 is satisfactory for self-feeding on pasture, providing of the grain ration is oats.

The grain ration of replacement gilts, young boars, and boars in e, may well consist of one-third ground oats. For mature sows and e boars not in service, the oats content of the grain ration may be r.

On lush legume or rape pasture, the protein supplement of ration 3 be deleted. However, the quantities of protein supplement indicated eeded when sows are grazing non-legume or other fair to poor pasture.

TABLE 60

HANDY LACTATING-SOW FEEDING GUIDE; FOR ALL AGES (1) IN DRY-LOT, AND (2) ON PASTURE[1]

Ingredients	For Sows in Dry Lot		For Sows on Pasture
	Ration No. 1, lbs.	Ration No. 2, lbs.	Ration No. 3, lbs.
Ground corn, wheat, barley, oats,[2] and/or sorghum	73	75	87
Alfalfa meal	15	15	...
Animal protein supplement (tankage, meat meal, fish meal, and/or dried milk)	6	6	6.5
Plant protein supplement (Soybean, cottonseed, linseed, and/or peanut meal)	6	4	6.5

[1]By the time the pigs are ten days to two weeks of age, lactating sows may be successfully self-fed. Lactating sows will consume from 2½ to 4½ pounds of concentrates daily per 100 pounds live weight, with mature sows approaching the lower side and gilts the upper side of this range.

[2]In general, oats should not constitute more than one-third of the ration, especially for young gilts.

TABLE 61

HANDY GROWING- AND FATTENING-PIG FEEDING GUIDE FOR PIGS IN DRY LOT[1]

Ingredients	Under 75 lbs. wt.[2]	75-100 lbs. wt.	100-150 lbs. wt.	150-200 lbs. wt.	200-250 lbs. wt.
	Ration No. 1, lbs.	Ration No. 2, lbs.	Ration No. 3, lbs.	Ration No. 4, lbs.	Ration No. 5, lbs.
Ground corn, wheat, oats, barley, and/or sorghum	58	77	80	83	86
Alfalfa meal	6	8	9	9	6
Animal protein supplement (tankage, meat meal, fish meal, and/or dried milk)	18	7	5	4	4
Plant protein supplement (soybean, cottonseed, linseed, and/or peanut meal)	18	8	6	4	4

[1]Young pigs require a much greater proportion of protein in the ration than do those approaching market weight. For this reason, less protein supplement is indicated in the above rations as fattening progresses. Of course, as pigs advance in age and weight, they consume a larger daily ration, although the percentage of protein in the mixture is decreased. For this reason, the "rule of thumb" is: "throughout life, a pig will consume about ½ pound of 40 per cent protein daily."

[2]This same ration is recommended for creep-feeding, thus avoiding any change in the ration at weaning time.

TABLE 62

HANDY GROWING- AND FATTENING-PIG FEEDING GUIDE FOR PIGS ON PASTURE[1]

Ingredients	Under 75 lbs. wt.[2]	75-100 lbs. wt.	100-150 lbs. wt.	150 lbs. up
	Ration No. 1, lbs.	Ration No. 2, lbs.	Ration No. 3, lbs.	Ration No. 4, lbs.
ıd corn, wheat, barley, r sorghum	72	82	89	95
al protein supplement age, meat meal, fish and/or dried milk)	14	9	5.5	2.5
protein supplement (soy- cottonseed, linseed, r peanut meal)	14	9	5.5	2.5

Young pigs require much more protein than do those approaching et weight. For this reason, less protein supplement is indicated in the rations as fattening progresses.

This same ration is recommended for creep-feeding, thus eliminating hange at weaning time.

ters in Formulating Rations and Feeding Swine

In formulating rations and in feeding swine, the following ts are noteworthy:

1. Feeds of similar nutritive properties can be interchanged ıe ration as price relationships warrant. This makes it pos- at all times to obtain a balanced ration at the lowest cost. e of these feeds are: (1) the cereal grains (corn, barley, at, oats, and sorghum), (2) the animal protein supplements kage, meat meal, fish meal, and dried milk), and (3) the t protein supplements (soybean, cottonseed, linseed, and ut meal).

2. The proteins, minerals, and vitamins are of especial im- ance during the critical periods in swine production. These (1) during gestation, (2) during lactation, and (3) from ı to 75 pounds in weight.

3. With good forage (ground alfalfa or pastures), the prob- of the supplement is simplified.

4. If wheat, barley, oats, and/or grain sorghum is used in- l of corn as the grain in a ration, the protein supplement be slightly reduced. These grains have a higher protein con- than corn.

5. When proteins of animal origin are used, adequate mineral protection can be obtained by allowing hogs free access to a two-compartment box or self-feeder with salt (iodized salt in iodine-deficient areas) in one side and feeding steamed bone meal (or better yet a mixture of one-third salt and two-thirds bone meal) in the other.

In feeding proteins of plant origin, a third compartment containing ground limestone or oyster shell flour (or a mixture of one-third salt and two-thirds of the calcium supplement) may be added. Most authorities recommend that minerals be self-fed free choice. Then the animal consumes them according to need.

TABLE 63

RECOMMENDED MINERALS AND ALLOWANCES FOR INCORPORATION (1) IN ENTIRE RATION, AND (2) IN PROTEIN SUPPLEMENT ONLY

Kind of Protein Supplement	Kind and Amounts of Minerals Required	
	When mixed with ration containing all concentrates	When mixed with protein supplement only
	lbs./100 lbs. mix	lbs./100 lbs. supplement
1. Tankage, meat meal, fish meal and/or dried milk constituting 1/3 or more of the source of proteins	0.25-0.5 salt	1.5 salt
2. Linseed, soybean, cottonseed, and/or peanut meal constituting most of the source of proteins	0.5 salt 0.75 ground limestone or oyster shell flour	1.5 to 2.0 salt 4.0-5.0 limestone or oyster shell flour

However, the mineral supplement may be incorporated in the entire ration. Usually 1 per cent by weight will prove adequate. If it is incorporated in the protein concentrate only, 5 to 6 pounds of mineral mixture should be added to each 94 to 95 pounds of high-protein feed. For these methods of feeding, Table 63 may serve as a guide.

6. Where there is insufficient sunlight or where dehydrated alfalfa meal is fed, 2 to 4 ounces of irradiated yeast should be added to each 1,000 pounds of feed.

7. Except for gestating sows, hogs are generally self-fed. All of the ingredients may be mixed together and placed in one self-feeder. Or the grain may be placed in one self-feeder or

partment) and the protein supplements (including any nd alfalfa) in another. If the (1) cereal grains and (2) pro- supplement (including any ground alfalfa) are hand-fed, grain and supplement should be fed separately, in the pro- ions indicated in the suggested rations.

8. An exception should be made to the cafeteria-style feed- when the grain ration consists of barley, oats, rye, or kafir. se are feeds that are higher in protein content than corn and h for this reason, are generally fed as a mixed ration. Other- , the pigs will often eat more protein supplement than is ssary to balance the ration. Likewise, when corn is fed as grain, sometimes such protein supplements as (1) roasted eans, (2) soybean oil meal, and (3) mixtures of tankage or meal and soybean oil meal, are too palatable to be fed sep- ely from the corn.

9. Full-fed fattening hogs will consume about 5 pounds of daily per 100 pounds live weight until they weigh 100 ds. They will eat about 4 pounds daily per 100 pounds weight this stage on to marketing.

ing Rations for Swine[1]

Any of the rations listed in Tables 59, 60, 61, and 62, for the ective classes and ages of swine, are suitable for use in fitting animals of similar classifications. In general, however, most rienced herdsmen feel that they can get superior bloom and lition by hand-feeding show animals rather than by self- ing. They also prefer mixing the ration with skim milk, but- ilk, or condensed buttermilk and feeding the entire ration he form of a slop.

Adding milk to a ration that is already properly balanced make for a higher protein content than necessary. On the r hand, most experienced herdsmen prefer using rations of ier protein content for fitting purposes. They feel they get e bloom that way. In general, however, when skim milk or ermilk is used in slop feeding, the protein feeds of the ration be reduced by one-half without harm to the animal.

In fitting show barrows, it may be necessary to decrease or ontinue slop-feeding 2 to 4 weeks before the show to avoid nchiness and lowering the dressing percentage.

[1] Further information on selecting, fitting, and showing swine is pre- ed in Chapter XIII of *Swine Husbandry*, a book by the same author and same publisher as *Animal Science*.

When oatmeal (hulled oats) is not too high priced, many successful hog showmen replace up to 50 per cent of the grain (corn, wheat, barley, oats, and/or sorghum) in the ration with oatmeal. They do this especially when fitting hogs—both breeding animals and fat barrows—in the younger age groups. Oatmeal is highly palatable, lighter, and less fattening than corn.

CHAPTER XXXII

CENTRAL MARKETING AND PACKER SLAUGHTERING OF HOGS

Hogs are marketed through the several channels open to all ses of livestock. In comparison with the marketing of cattle sheep, however, the marketing of hogs differs in the follow- respects: (1) There has been a greater proportionate increase irect marketing of hogs with the advent of improved high- s and truck transportation; (2) relatively fewer hogs are n out of the market for further feeding because of parasite disease problems; and (3) the proportion of hogs ghtered on farms far exceeds that of cattle or sheep because ne greater ease of slaughtering and the adaptation of pork uring.

Hog slaughtering is also unique in that the carcasses are om sold, such as is the case with beef, veal, mutton, and lamb. ead, hogs are reduced to the wholesale cuts at the place of ghter. Also, much more pork is cured than is the case with or lamb; and pork fat (lard) is not classed as a by-product, ough the surplus fats of beef, veal, mutton, and lamb are in by-product category.

ADING HOG MARKETS

As would be expected, the leading hog markets of the United es are located in or near the Corn Belt—the area of densest population. With the advent of the motor truck and improved ways, the pork packing plants tended to move nearer the s of hog raising. Thus, during the past two decades, local or ior packers have increased in numbers. In order to meet this d competition, the large packers at more distant points re- ed to direct buying and the purchase of interior plants.

Chicago holds a commanding lead in receipts of hogs, the rank of the other major hog markets shifts considerably rding to feed supplies and general economic conditions. The argest hog markets, by rank, and their receipts are listed in e 64.

TABLE 64

TOTAL RECEIPTS OF TEN LEADING HOG MARKETS; AVERAGE 1944 TO 1948, BY RANK 1949[1]

Market	Average hog receipts 1944-1948	1949
Chicago, Illinois	3,927,055	3,425,252
St. Louis National Stock Yards, Illinois	2,496,195	2,868,632
South St. Paul, Minnesota	2,346,728	2,637,239
Omaha, Nebraska	2,430,018	2,573,378
Indianapolis, Indiana	1,968,091	2,190,401
Sioux City, Iowa	1,837,343	1,948,433
St. Joseph, Missouri	1,318,086	1,471,671
Denver, Colorado	852,361	1,135,502
Peoria, Illinois	814,422	865,457
New York, N. Y.	815,141	845,053
United States Total[2]	31,776,372	33,118,468

[1] *Livestock Market News, Statistics and Related Data, 1947* U. S. Dept. of Agri., p. 14.
Ibid., 1949, August, 1950, p. 10.
Livestock Meats and Wool Market Statistics and Related Data, 1945. U. S. Dept. of Agri., p. 13.
[2] Included 65 markets.

MARKET CLASSES AND GRADES OF HOGS

The market classes and grades of swine were developed in much the same manner as the classifications of cattle were developed and brought into use. They also serve much the same purpose. Swine classes and grades do differ from those used in cattle and sheep in that: (1) There are no age divisions by years (e.g, cattle are classified as yearling and two-year-old and over); (2) only a limited number of hogs are returned to the country as feeders for further growth or fattening; and (3) rarely are hogs of any kind purchased on the market for use as breeding animals. As in the classification of market cattle, the class of market hogs indicates the use to which the animals are best adapted, whereas the grade indicates the degree of perfection within the class.

The generally accepted market classes and grades of hogs are summarized in Table 65.

Hogs or pigs	Use selection	Sex class	Weight divisions, pounds	Commonly used grades
Hogs	Slaughter Hogs	Barrows and Gilts (Often called "butcher hogs")	120-140 240-270 140-160 270-300 160-180 300-330 180-200 330-360 200-220 360-400 220-240 400 lbs. up	Choice No. 1, Choice No. 2, Choice No. 3, Medium, and Cull.
		Sows (or packing sows)	270-300 400-450 300-330 450-500 330-360 500-600 360-400 600 lbs. up	Choice (Fat type) Choice (Meat type) Good, Medium, Cull
		Stags	All Weights	Ungraded
		Boars	All Weights	Ungraded
	Feeder Hogs	Barrows and Gilts	120-140 140-160 160-180	Choice, Good, Medium, Common
Pigs	Slaughter Pigs	Barrows, Gilts, and Boars	Under 30 30-60	Ungraded
		Barrows and Gilts	60-80 80-100 100-120	Choice, Good, Medium, Cull
	Feeder Pigs	Barrows and Gilts	80-100 100-120	Choice, Good, Medium, Common

Factors determining market classes of hogs

The market class of hogs is determined by the following factors: (1) hogs versus pigs, (2) use selection, (3) sex, and (4) weight.

HOGS AND PIGS:

All swine are first divided into two major groups according to age: hogs and pigs. Although actual ages are not observed, the division is made largely by weight in relation to the apparent age of the animal. Young animals weighing under 120 pounds (under about four months of age) are generally known as pigs, whereas those weighing over 120 pounds are called hogs.

USE SELECTION OF HOGS AND PIGS:

Hogs and pigs are each further divided into two subdivisions as slaughter animals and feeders. Slaughter swine are hogs and pigs that are suitable for immediate slaughter. The demand for light-weight slaughter pigs is greatest during the holiday season when they are in demand as roasting pigs for hotels, clubs, restaurants, steamships, and other consumers. Such pigs weigh from 15 to 20 pounds, are dressed shipper style (with the head on), and must produce a plump and well-proportioned carcass. Slaughter hogs (the older animals) are in demand throughout the year.

Feeder swine include those animals that show ability to take on additional weight and finish. The feeder group is relatively small. Moreover, because of the greater disease hazard with hogs, this class is under very close federal supervision. Before being released for return to the country, feeder swine must be inspected from a health standpoint, vaccinated against hog cholera, and then either sprayed or dipped as a precautionary measure to prevent the spread of disease germs or parasites.

THE SEX CLASSES:

The sex class is used only when it affects the usefulness and selling price of animals. In hogs, this subdivision is of less importance than in cattle. Thus barrows and gilts are always classed together in the case of both slaughter and feeder hogs. This is done because the sex condition affects their usefulness so little that a price differentiation is not warranted. In addition, because the carcass is not affected, no sex differentiations are made for slaughter pigs under 60 pounds in weight. The terms barrow, gilt, sow, boar, and stag are used to designate

sex classes of hogs. The definition of each of these terms
ows:

Barrows.—A castrated male swine animal that was cas-
ed at an early age—before reaching sexual maturity and be-
developing the physical characteristics peculiar to boars.

Gilt.—A female swine that has not produced pigs and which
not reached an evident stage of pregnancy.

Sow.—A female swine that shows evidence of having pro-
ed pigs or which is in an evident stage of pregnancy. Piggy
s are usually docked 40 pounds on the market.

Boar.—An uncastrated male swine animal of any age.
ure boars should always be "stagged" and fed a month longer
re being sent to market. The market value of boars is neces-
ly low, for a considerable number are condemned as unfit for
an consumption, primarily because of odor.

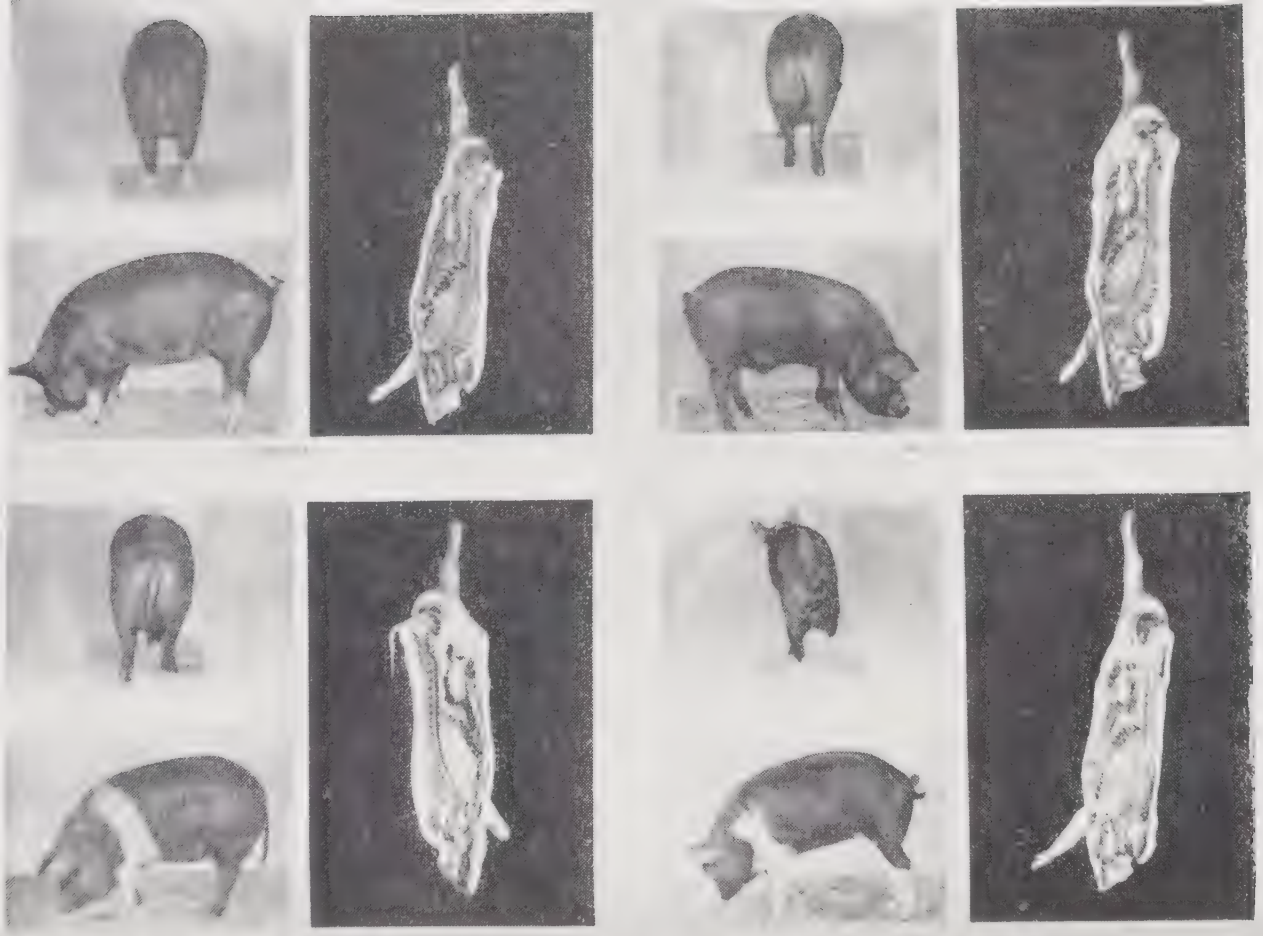
Stag.—A stag is a male swine animal that was castrated
r it had developed the physical characteristics of a mature
. Because of relatively thick skins, coarse hair, and heavy
es, stags are subject to a dockage of 70 pounds on terminal
kets. When marketed direct, stags are usually not docked in
ght but are purchased at a price that reflects their true value
n a meat standpoint.

IGHT DIVISIONS:

Occasionally, the terms light, medium, and heavy are used
ndicate approximate weights, but most generally the actual
ge in weight in pounds is specified both in trading and in
ket reporting. Moreover, hogs are usually grouped according
elatively narrow weight ranges because variations in weight
ct (1) the dressing percentage, (2) the weight and desira-
y of the cuts of meat, and (3) the amount of lard produced.
eavier weights produce more lard). Boars and stags are not
ally subdivided according to weights.

market grades of hogs

The market grade for swine, as for other kinds of livestock,
specific indication of the degree of excellence within a given
s based upon conformation, finish, and quality. While no
cial grading of live animals is done by the U. S. Department
Agriculture, market grades do form a basis for uniform re-
ting of livestock marketings. It is intended that the grade of
ghter hogs on foot be correlated with the carcass grade. The
rket grades of hogs are: Choice No. 1, Choice No. 2, Choice



Choice No. 3 Medium

Fig. 317. The four *tentative* top market grad s of slaughter barrows and gilts and correspond-

3, Medium, and Cull. As will be noted, the market grades of
ie differ from the grades of cattle in that: (1) Hogs possess
grades instead of the seven common to cattle; (2) the top
le of hogs is choice instead of prime; (3) three choice grades
ogs are used because of the wide variation in fatness and in
l of lean cuts; and (4) no Cutter or Canner designations are
l in hogs; instead the lowest grade is known as Cull.

The designations Choice No. 1, Choice No. 2, and Choice No.
re used to differentiate between slaughter hogs of three de-
s of fatness all of which are finished and produce choice
ity carcasses and cuts but differ in proportion of fat to lean
Choice No. 1 has less fat and more lean than Choice No. 2.
s regrettable that the distinction between grades is seldom
le in actual practice, at least from the standpoint of price
erential.

As a rule, slaughter pigs that weigh under 60 pounds are
graded because they have not reached sufficient maturity for
ations in their conformation, finish, and quality to affect
erially the market value.

HER HOG MARKET TERMS AND FACTORS

In addition to the rather general terms used in designating
different market classes and grades of hogs, the following
ns and factors are frequently of importance:

sters

"Roasters" refer to fat, plump, suckling pigs, weighing 15 to
pounds on foot. These are dressed shipper style (with the
d on). When properly roasted and attractively served with
traditional apple in the mouth, roast pig is considered a great
icacy for the holiday season.

ughs (or "throw-outs")

The term "roughs or throw-outs" is frequently applied to
rse, rough hogs lacking in condition. Carcasses from such
gs are used for the cheaper class of trade, both as cured and
sh pork.

vernments

"Governments" are suspicious animals that federal inspec-
s tag at the time of the antemortem inspection to indicate
t more careful scrutiny is to be given in the postmortem in-
ction. If the carcass is deemed unfit for human consumption,
s condemned and sent to the inedible tank.

Cripples

"Cripples" are hogs that are not able to walk and that must be hauled to the packing plants in "cripple carts."

Dead hogs

"Dead hogs" are those that arrive dead at the market. These carcasses are sent to the tanks for conversion into inedible grease, fertilizer, etc.

PACKER SLAUGHTERING AND DRESSING OF HOGS

Table 66 shows the proportion of hogs slaughtered in federally inspected plants. The total figure refers to the number dressed in all establishments and on farms.

TABLE 66

PROPORTION OF HOGS SLAUGHTERED IN FEDERALLY INSPECTED PLANTS FROM 1945 TO 1949[1]

Year	Hogs Dressed	
	Federally inspected	Total
	(thousands)	(thousands)
1945	40,960	71,891
1946	44,394	76,244
1947	49,116	74,710
1948	47,615	71,936
1949	53,032	75,293

[1] *Livestock Market News, Statistics and Related Data, 1949*, U. S. Dept. of Agri., August, 1950, p. 24.

Although modern equipment may be lacking, the slaughtering procedure on the farm or in a small local plant is much the same as that followed in a large federally inspected plant. Only the procedure used in a modern packing plant will be discussed.

After purchase, hogs are driven from the holding pens to the packing plant where they are given a shower and are held temporarily in a small pen while awaiting slaughter.

Steps in slaughtering and dressing hogs

The chain method of slaughtering is used in killing and dressing hogs. In this method, the following steps are carried out in rapid succession:

1. **Shackling and hoisting.**—The hogs are shackled just above the hoof on the hind leg and are then hoisted to an overhead rail.

2. **Sticking.**—The "sticker" sticks the hog just under the point of the breast bone, severing the arteries and veins leading to the heart. The animal is allowed to bleed for a few minutes.

3. **Scalding.**—The animals are next placed in a scalding vat about four minutes. By means of automatically controlled m jets, the temperature of the water in the vats is maine at 142° to 145° F. The scalding process loosens the hair scurf.

4. **Dehairing.**—After scalding the animals are elevated into hairing machine which scrapes them mechanically. In modern king plants a single dehairing machine will handle up to five dred hogs per hour. Most large plants are equipped with twin chines which provide a scraping capacity of a thousand hogs hour.

5. **Returned to overhead tracks.**—As the animals are disrged from the dehairing machine, the gam cords of the hind s are exposed; and gambrel sticks are inserted in the cords. en the carcass is again hung from the rail.

6. **Dressing.**—A conveyor then moves the carcass slowly ng a prescribed course where attendants perform the follow- tasks:

(a) Washing and singeing.
(b) Removing the head.
(c) Opening the carcass and eviscerating.
(d) Splitting or halving the carcass with a cleaver or electric saw.
(e) Removing the leaf fat.
(f) Exposing the kidneys for inspection and facing the hams (removing the skin and fat from the inside face or cushion of the ham).
(g) Washing the carcass and sending it to the coolers where the temperature is held from 31° to 38° F. (Rapid chilling is desirable.)

During the dressing process, federal inspectors carefully amine the head, viscera, and carcass. If the carcass gives no idence of disease, it is stamped "U. S. Inspected and Passed" ior to being sent to the coolers. If it shows evidence of a dissed condition and is not considered wholesome, it is stamped J. S. Condemned" and is sent to the inedible tank room along th the viscera. There the carcass is cooked under steam pres- re in sealed tanks until all the disease germs are destroyed.

acker versus shipper style of dressing

The two common styles of dressing hogs in packing plants e: Packer style and shipper style. In general, the packer style followed, and this system is almost exclusively used when

carcasses are to be converted into the primal cuts. In packer-style dressing, the backbone is split full length through the center; the head, without the jowl, is removed; and the kidneys and the leaf fat are removed and the hams faced.

The shipper style is ordinarily limited to light-weight slaughter pigs that are sold as entire carcasses to the wholesale trade. In this style of dressing, the carcass is merely opened from the crotch to the tip of the breastbone; the backbone is left

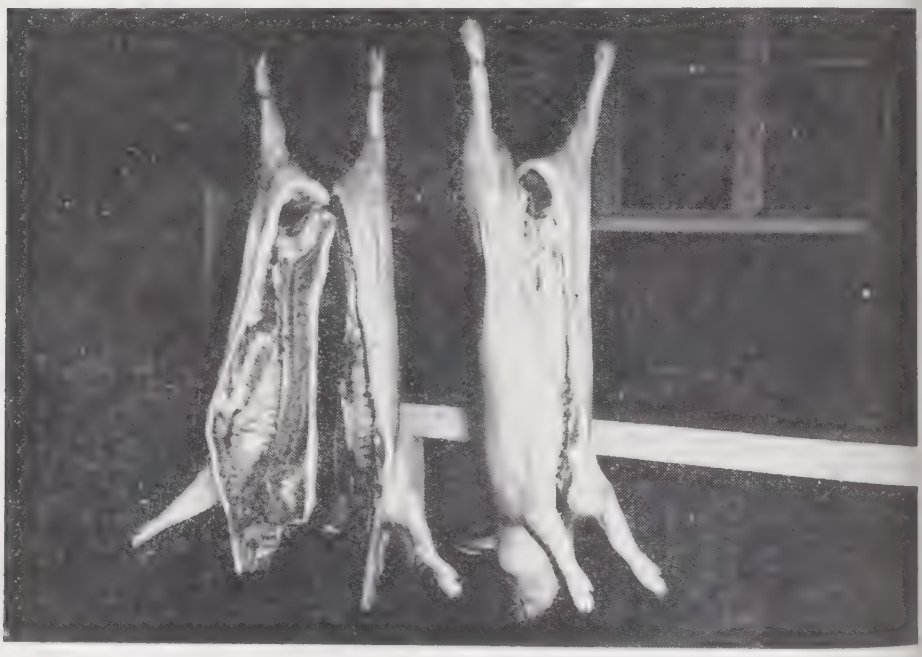


Fig. 318. Packer (left) versus shipper (right) style of dressing. Both hogs dressed 75 per cent shipper style, but subsequent removal of the head, leaf fat, and kidneys from the carcass to the left—in preparing it packer style—lowered the dressing per cent of this carcass a further 4 per cent. (Courtesy, The State College of Washington.)

intact; the leaf fat is left in; and the entire head is left attached. Roasting pigs are dressed shipper style and prior to cooling are placed in a trough with front legs doubled back from the knee joints and the hind legs extending straight back from the hams.

When dressed packer style, the carcass yields are 4 to 8 per cent less than can be obtained shipper style. The lower yield is due to the removal of the head, leaf fat, kidneys, and ham facings.

The dressing percentage

Because hogs have a smaller digestive capacity, fill is less important in determining their dressing percentage than is the

with cattle. The degree of fatness and the style of dressing the important factors affecting dressing percentage in hogs. It is generally recognized that fat, lardy type hogs give a ıer dressing percentage than can be obtained with meat- e or bacon-type animals. Because lard frequently sells at a er price than is paid for hogs on foot, an excess yield of lard obviously represents an economic waste of feed in producing animals and is undesirable from the standpoint of the pro- or. Accordingly, many producers and slaughterers are slowly ving at the conclusion that the present method of attaching at importance to the projected dressing percentage of hogs utmoded. The more progressive buyers are now focusing their ntion on the cut-out value of the carcass, especially on the ximum yield of the more sought primal cuts of high quality.

In addition to their relatively smaller barrel and chest ity, hogs are dressed with their skin and shanks on. Con- uently, they dress higher than other classes of slaughter mals.

The average live weight of hogs, dressed packer style by mercial meat packing plants, and their percentage yield in t for the ten-year period 1938 to 1947 were as follows:[1]

	Average live weight (Pounds)	Average yield in meats (Pounds)	Dressing percentage
Hogs	245.9	185.2	75.3

SPOSITION OF THE PORK CARCASS

Almost all hog carcasses are cut up at the slaughtering nt and are sold in the form of wholesale cuts. In most parts the country not more than 1 to 2 per cent of the pork in large king plants is sold in carcass form. The whole-carcass trade argely confined to roasting and slaughter pigs.

The handling of pork differs further from that of beef and ıb in that only a relatively small percentage, about 30 per t, of the pork is sold fresh. The remaining 70 per cent is ed by various methods, is rendered into lard, or is manufac- ed into meat products. In general, loins, shoulders, and spare- s are most likely to be sold as fresh cuts. But it must be re- mbered that practically every pork cut may be cured, and, der certain conditions, is cured. Because pork is well adapted curing, it has a decided advantage over beef and mutton, which

[1] *Livestock Market News, Statistics, and Related Data*, U. S. Dept. of ri., 1948, pp. 78 and 79.

are sold almost entirely in the fresh state. The hog market is stabilized to some extent by this factor.

THE HOG CARCASS AND ITS CUTS

A minimum of twenty-four hours chilling at temperatures ranging from 31° to 38° F. is necessary to remove properly the animal heat and give the carcasses sufficient firmness to make possible a neat job of cutting. After chilling, the carcasses are brought to the cutting floor where they are reduced to the wholesale cuts.

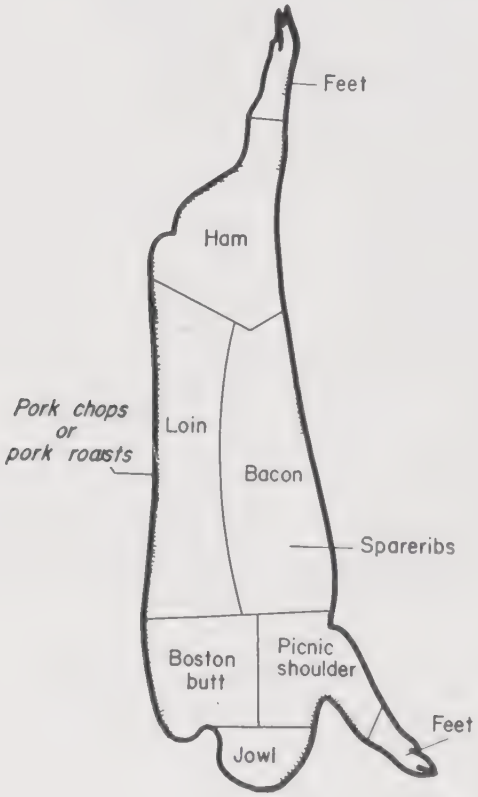


Fig. 319. Wholesale cuts of pork and some of the common retail cuts. (Drawing by R. F. Johnson.)

The method of cutting varies somewhat according to the value of lard and the relative demand for different cuts. Despite some variation, the most common wholesale cuts of pork are ham, bacon, loin, picnic shoulder, Boston butt, jowl, spareribs, and feet.

Market hogs weighing from 180 to 200 pounds will have about 45.5 per cent of their live weight in the four primal cuts:

ham, shoulder, loin, and bacon belly. Yet, because of the tively higher value per pound of these cuts, they make up e-quarters of the value of the entire carcass.

RD

Lard is the fat rendered (melted out) from fresh, fatty tissue. From 10 to 25 per cent—with an average of 15 per —of the hog carcass is made into lard in the large packing ses. The proportion varies with the type, weight, and finish he hogs, and the relative price of lard and the cuts of meat. l is considered a primary product of hog slaughter and not a roduct.

ls of lard

Lard is classified according to the part of the animal from h the fat comes and the method of rendering.

TTLE-RENDERED LEAF LARD:

Kettle-rendered leaf lard is made from leaf fat only. It is lered in a steam-jacketed open kettle at a temperature of to 250° F. It is very white in color, fine textured, and pos- es excellent keeping qualities and a pleasing flavor. It is the iest grade of lard.

TTLE-RENDERED LARD:

Kettle-rendered lard is made from back fat and leaf fat, lly in equal amounts. It is also rendered in a steam-jacketed kettle but at a temperature of 240° to 260° F. Kettle- lered lard has good keeping qualities, but it is likely to be ewhat darker than kettle-rendered leaf lard, to which it ks second in grade.

ME STEAM LARD:

Probably 85 per cent of packing house lard is of the prime m type. It is made from killing and cutting fats that are lered in a closed tank under steam pressure of from 30 to 50 nds and at a temperature of 285° F.

UTRAL LARD:

Neutral lard is made entirely from leaf fat that is rendered very low temperature of about 120° F. It is used almost en- ly in the manufacture of oleomargarine.

Y-RENDERED LARD:

Dry-rendered lard is essentially a kettle-rendered lard, ex- that the fat is melted in a closed container, usually under

reduced pressure. This method of rendering gives a product that has a fine flavor and excellent keeping quality.

NEW PROCESS LARD (OR DEODORIZED OR HYDROGENATED LARD):

New process lard is deodorized lard to which extra atoms of hydrogen and a stabilizing agent (inhibitors of vegetable origin) have been added. Such lard is bland, has a high melting point, and is less subject to rancidity than ordinary lard. New-process lard was first placed on the market in 1941.

LARD SUBSTITUTES:

Lard substitutes, which are sometimes used in place of lard, are made from: (1) lard and other animal fats mixed with vegetable oils, (2) vegetable oils alone, and (3) hydrogenated vegetable oils, the most prominent of which are cottonseed and cocoanut oil.

Reference

Added chapters on Grains and Other High Energy Feeds for Swine; Protein and Vitamin Supplements for Swine; Pasture Crops For Swine; Buildings and Equipment For Swine; Swine Health, Disease Prevention, and Parasite Control; and Selecting, Fitting, and Showing Swine are included in the following book by the same author and the same publisher as *Animal Science*:

Swine Husbandry

CHAPTER XXXIII

HISTORY AND DEVELOPMENT OF THE HORSE AND MULE INDUSTRY[1]

The evolution and transformation of the horse from the
-day wild forms, its subsequent domestication, and the over-
ing uses made of it in both war and peace is a fascinating
.

LUTION OF THE HORSE

Fossil remains prove that members of the horse family
ed the plains of America (especially what is now the Great
s area of the United States) during most of Tertiary time,
fifty-five million years ago. Yet no horses were present on
continent when Columbus discovered America in 1492. Why
perished, only a few thousand years before, is still one of the
plained mysteries of evolution. As the disappearance was so
plete and so sudden, many scientists believe that it must have
caused by some contagious disease or some fatal parasite.
rdless of why horses disappeared, it is known that conditions
merica were favorable for them at the time of their reestab-
nent by white man.

Through fossil remains, it is possible to reconstruct the
ution of the horse, beginning with the ancient four-toed
stor, the eohippus (meaning "dawn horse"). This was a small
like animal ten to twenty inches in height with four toes on
front feet and three toes on the hind feet and a short neck.
as well adapted to travelling and feeding on the herbage of
mp lands. Gradually, the descendants of eohippus grew in
and changed in form, evolving into a three-toed animal
vn as mesohippus, which was about twenty-four inches in
ht or about the size of a collie dog. Further changes con-

[1]In the preparation of the horse section of *Animal Science*, Chapters
III through XLIV, the author had the benefit of the authoritative re-
and suggestions of the following persons: Mr. Ira Drymon, owner of
gher Farm and Past President of the Horse Association of America,
ngton, Kentucky; Mr. Ed Heinemann, Field Secretary, Washington
e Breeders' Association, Seattle, Washington; Mrs. Benton Dryden,
e owner and enthusiast, Woodstock, Vermont; and Mr. Gene Stark,
t Horseman, The State College of Washington, Pullman, Washington.

tinued, transforming the animal from a denizen of the swamp to a creature capable of surviving in the forest and finally to one adapted to the prairie. In terms of conformation, the animal grew taller. The teeth grew longer, stronger, and more roughened to suit the gradual changes to grazing on the prairie. The cannon bones, metacarpals, and metatarsals lengthened; the middle toe (or third toe) grew longer and stronger, forming a hoof; and the other toes (second and fourth toes) gradually disappeared except for vestiges, the slender bones known as splints, under the skin. The transformation in length and structure of foot made for greater speed over prairie type of terrain, thus enabling the animal to feed farther and farther from water, and providing for greater safety in its struggle to survive. The horse is an excellent example, therefore, of the slow adaptation of animal life to changing conditions in environment, climate, food, and soil. The animal was transformed from one adapted to a swamp type of environment to one adapted to the prairie. Though all horses eventually perished in the New World and none were present on the continent when America was discovered, fortunately some of these animals had long before emigrated to Asia and Europe at a time when there was a land bridge connecting Alaska and Siberia (now the Bering Strait). These emigrants formed the sturdy wild European stock from which the horse family of today has descended, and this stock also populated Africa with its asses and zebras.

ORIGIN AND DOMESTICATION OF THE HORSE

The horse was probably the last of present-day farm animals to be domesticated by man. According to early records, after subduing the ox, the sheep and the goat, man domesticated the ass and then the camel; and, finally, the horse became his servant.

Horses appear to have been domesticated first in Central Asia or Persia more than 3,000 years B. C., for they spread westward through southern Europe in the time of the Lake Dwellers. They were reported in Babylonia as early as 2000 B. C., perhaps coming into the country via neighboring Persia.

Although the Egyptians—the most advanced civilization of the day—had domesticated and used the ass from the earliest times, horses were wholly unknown to them until the dynasty of the Shepherd Kings, who entered Egypt from Asia in 1680 B. C. It is reported that, thereafter, the horse was much favored in Egypt.

Fig. 320. The evolution of the horse, beginning with the ancient four-
eohippus (bottom of picture) and gradually progressing to the present-
one-toed equus (top of picture). Note the transformation in the length
structure of the foot, in the size of the head, and in the size of the teeth.
animal was transformed from a denizen of the swamp to a creature
ted to the prairie. (Courtesy, American Museum of Natural History,
York.)



Fig. 321. Joseph using horses in his move to Egypt (about 1500 B.C.) from a miniature painting in the Bible of the Counts of Toggenburg. 15th century. (Courtesy, The Bettmann Archive.)

Presence of the horse seems to have prompted the invention
ıe chariot, a type of vehicle drawn by horses that the Egyp-
s used in war and other pursuits. The Bible also relates that
ı Joseph took his father's remains from Egypt back to
ıan "there went up with him both chariots and horsemen."[1]
probable that the Egyptians were largely responsible for the
ıd of domesticated horses to other countries.



Fig. 322. Distinguished young Greek in fashionable riding habit. Bowl
ting, 500 B.C. Though the Greeks were accomplished horsemen, at this
the use of the saddle and stirrups appears to have been unknown.
ırtesy, The Bettmann Archive.)

Certainly, Greece was not even peopled, and there were no
ses in Arabia during the early period when they were flourish-
in Egypt. But horses and chariots were in use in Greece at
t a thousand years before Christ, to judge from the account

[1]Genesis: L:9.

of their use in the siege of Troy. It is also interesting to note that the first and most expert horsemen of Greece, the Thessalians, were colonists from Egypt. As evidence that the Greeks were accomplished horsemen, it might be pointed out that they developed the snaffle bit at an early period. One of their number is also said to have originated the axiom: "No foot, no horse." Yet the use of the saddle and stirrups appears to have been unknown at this time.

From Greece, the horse was later taken to Rome and from there to other parts of Europe. The Romans proved to be master horsemen. It was they who invented the curb bit. According to



Fig. 323. Horses vary in size and use. The Shetland pony foal (left) is thought to have descended from the small, shaggy wild stock of northern Europe; whereas the draft horse (right) is thought to have descended primarily from the ponderous wild black horse of Flanders. (Courtesy, Iowa State College.)

rians, when Caesar invaded Britain, about 55 B. C., he took es with him. Although there were other horses in Britain e time of the Roman occupation, Eastern breeding was prob- greatly infused at this time—thus laying the foundation for Blood Horse of today.

The Arabs, strangely enough, did not use horses to any nt until after the time of Mohammed (570 to 632 A. D.), nding on camels before that time. As evidence of this fact, noted that in the seventh century after Christ, when Ma- et attacked the Koreish near Mecca, he had but two horses s whole army; and at the close of his murderous campaign, ough he drove off twenty-four thousand camels and forty sand sheep and carried away twenty-four thousand ounces lver, not one horse appeared in his list of plunder. This would to indicate rather conclusively that Arabia, the country se horses have done so much to improve the horses of the d, was not the native home of the horse and that the Arabs ot use horses until after the time of Christ.

It seems incredible that all the various breeds, colors, and s of draft, light, and pony horses should have descended a common wild ancestor. Rather, there were probably many rent wild stocks giving descent to domestic horses.

Wild Horse of Asia

The wild horses of Asia, which are sometimes referred to he Oriental light-legged horses, were of Asiatic origin, tracing wild horse of the Asiatic deserts (now extinct). Historic ence indicates that this group of horses gave rise to most of swift and slenderly built breeds of modern times. The Ara- , the Barb, and the Turk are all descendants of these animals; in turn, the Thoroughbred was originated from these stocks.

Wild Horse of Europe

The European wild horse, sometimes referred to as the opean forest type, continued to live in the forests of Germany Scandinavia until historic times; and wild horses are believed ave lived in the Vosges Mountains on the western border of ace until the year of 1600. One of the pagan practices of the ient German tribes was the sacrifice of horses and the eating heir meat at religious feasts. To this day one may find a relic orse worship in the horse skulls set on the gables of houses barns in southern Germany.

The European wild horse was the wild black horse of Flanders. This was a stocky animal that possessed considerably more size and scale than the Oriental type. This draft type was native to Western Europe at the time of the Roman invasion. It was the forerunner of the great war horses of the Middle Ages. The latter, in turn, fathered the modern draft breeds.

Not all wild horses of Europe were large, however, for small, shaggy animals were native to northern Europe. They were strong and hardy and required less feed than other types of horses. These animals are thought to be the progenitors of the Shetland pony.

The Tarpan

Though now extinct, the tarpan—a small dun-colored, genuine wild species of horse—was formerly abundant everywhere in southern Russia and Central Asia. These animals were hated by the farmers because they devoured their crops and especially because the tarpan stallions constantly recruited domestic mares for their wild bands. For these reasons, they were killed off by the Russians, finally being completely exterminated by the year 1870.[1]

Przewalsky's Horse

The only surviving species of original wild horses—not feral or escaped from domestication—known to exist at the present time is the Przewalsky's horse (or the Asiatic wild horse). This is the wild horse discovered by the Russian explorer, Przewalsky, in 1879, in the northwestern corner of Mongolia. It is a small, stockily built and distinctly yellowish horse, with an erect mane and no forelock. There is usually a dark stripe on the shoulders and down the middle of the back. Like the wild mustang or feral horses of the frontier days, Przewalsky's horse separate into bands, seldom more than forty in number, with a stallion leader in each group. At the present time, it is reported that only three wild bands remain. Fortunately, however, live specimens have been brought to Europe and America where they are being preserved and propagated successfully in captivity. When crossed on domestic horses, the hybrids are fertile, which proves that Przewalsky's horse is very closely related to the domestic horse.

It is not intended to imply that Przewalsky's horse was the foundation stock of any or all of the present-day improved breeds

[1]Some authors believe the Tarpan to have been a feral type, i.e., horses escaped from domestication, and not a distinct wild form. Certainty as to this point can now scarcely be gained.



Fig. 324. Przewalsky's horse. This is the only surviving species of orig- wild horses—not feral or escaped from domestication—known to exist e present time. Note that the animal is small and stockily built, with rect mane and no forelock. (Courtesy, New York Zoological Society, York.)

ughout the world. Rather, this wild horse of Asia is ex- nely interesting because it is the only one known to have ived the vicissitudes of time.

GIN AND DOMESTICATION OF THE DONKEY

The two species of the horse family that have been tamed man are *Equus caballus*, the horse, and *Equus asinus*, the or donkey. The history of the domestic donkey is as clear hat of the horse is obscure. Donkeys were first domesticated Egypt, where they served man from earliest times. Good fig- s of them appear on slates of the First Dynasty, about 3100 C. Domestic donkeys are descended from the wild donkey (the ian wild ass) of North Africa, a species which is now almost nct. Because of the frequent tendency to stripes on the legs, ever, some zoologists also think that the domestic donkey is ted to the Somali wild ass of Africa.

From Egypt, the use of the domestic donkey spread into thwestern Asia sometime prior to the year 1000 B. C. The

Bible first refers to the ass in relating how Abraham, the patriarch of the Old Testament, rode one of these animals from Beersheba to Mount Mordah. Every child is familiar with the fact that Jesus rode into Jerusalem on an ass. This mode of transportation was not unusual at the time of Christ, for donkeys were then the common saddle animals throughout the Near East.

As is generally known, the donkey is commonly used in this country in the production of mules. Mules have been known from very ancient times, as we learn from accounts of the Trojan war.



Fig. 325. A Mongolian wild ass in the Gobi desert in Asia. (Courtesy, American Museum of Natural History, New York.)

POSITION OF THE HORSE IN THE ZOOLOGICAL SCHEME

The following outline shows the basic position of the domesticated horse in the zoological scheme:

Kingdom *Animalia:* Animals collectively; the Animal Kingdom.

Phylum *Chordata:* One of the approximately twenty-one phyla of the animal kingdom.

Class *Mammalia:* Mammals, or warm-blooded, hairy animals that produce their young alive and suckle them for a variable period on a secretion from the mammary glands.

Order *Perissodactyla:* Nonruminant hoofed mammals, usually with an odd number of toes, the third digit the largest and in line with the axis of the limb. This suborder includes the horse, tapir, and rhinoceros.

Family *Equidae:* The members of the horse family may be distinguished from the other existing perissodactyla (rhinoceros and tapir) by their comparatively more slender and agile build.

Genus *Equus:* Includes the horse, asses, and zebras.

Species *Equus caballus:* The horse is distinguished from asses and zebras by the longer hair of the mane and tail, the presence of the "chestnut" on the inside of the hind leg, and by other less constant characters such as larger size, larger hoofs, more arched neck, smaller head, and shorter ears.

N'S USE OF THE HORSE

The name horse is derived from the Anglo-Saxon *hors*, ning swiftness; and the word horseman comes from the ew root "to prick or spur."[1] These early characterizations ie horse, within themselves, tell somewhat of a story. Per- the very survival of the wild species was somewhat depend- upon its swiftness, which provided escape from both beast man. The Hebrew description of a horseman was obviously gned after the horse had been domesticated and ridden by

.

The various uses that man has made of the horse down ugh the ages, in order of period of time, are: (1) as a source od, (2) for military purposes, (3) in the pastimes and sports ie nations, and (4) in agricultural and commercial pursuits.

[1] The Jews were forbidden to use horses by divine authority. In fact, were required to hamstring horses captured in war.

The Horse As a Source of Food

Man's first use of the horse was as a source of food, these animals being hunted by Paleolithic (Old Stone Age) man. This was prior to their domestication. These earliest records date back to some 25,000 years ago. Perhaps the best preserved record of this type consists of the cracked and dismembered bones of horses, mostly young animals, found around old camp sites. One bone heap of this sort is at Solutre, in the Rhone Valley in southern France. It is estimated that this one camp site contains the remains of 100,000 horses.

Following domestication, which is thought to have occurred some time toward the end of the New Stone Age, it is reasonable to surmise that mares were milked for human food—a practice still followed in certain parts of the world. Mares may give from three to nine gallons of milk per day.

The Horse for Military Purposes

Unfortunately, not long after domestication of the horse, man used him for waging war. About 1500 B. C., Pharaoh pursued the Israelites to the Red Sea using chariots and horses.[1] This would seem to imply that the Egyptian army used horses both as cavalry and to draw vehicles.

During the glamorous days of the "knight in armour," horses of size, strength, and endurance were essential. The Great Horse of medieval times was the knight's steed. Usually stallions were used. Often the knight and his armour weighed 350 to 425 pounds. During the Crusades and for several centuries after, the clad-in-armour types of warrior relied upon sheer weight to beat down the enemy.

The deeds of great warriors, mounted on their favorite chargers, have long been perpetuated in marble or bronze. Even in this atomic age, it is incredible to conceive that Generals Marshall, Eisenhower, or MacArthur some day will be sculptured seated at a telephone or in a jeep. Every school boy vividly associates Alexander the Great with his charger, Bucephalus; Napoleon with his famous horse, Marengo; the Duke of Wellington with his favorite mount, Copenhagen; George Washington, receiving the surrender of Cornwallis' army at Yorktown, with his handsome mount, Nelson; and General Grant with his horse, Jack.

[1]Exodus XIV:7.

Many people are under the erroneous impression that no s were used in World War II. Nothing could be further from ruth. But this is another story, to be related at the end e present chapter.

Horse in the Pastimes and Sports of Nations

As early as 1450 B. C., the sports-loving Greeks introduced orse in the Olympic games, in both chariot and horse races. most celebrated of these events was held at Olympia every



Fig. 326. Chariot driven through Pompeii. The horse-drawn chariot used by the sports-loving Greeks in chariot races, as well as in war other pursuits. (Courtesy, The Bettmann Archive.)

th year in honor of Jupiter. However, because of the scarcity orses, very few were used in early contests. Classes were ded according to age—and sometimes sex—and the distance he course was approximately four miles.

For these important events, the Greeks trained both themes and their horses. The chariot races were even provided settings to tempt the charioteers to daring deeds. The chariin use were a low, two-wheeled, narrow-track type of vehicle.

Horse In Agricultural and Commercial Pursuits

For many years following domestication, horses were used purposes of war and sport. Their use in pulling loads and ng the soil is a comparatively recent development.

There is no evidence to indicate that the horse was used in Europe to draw the plow prior to the tenth century, and oxen remained the common plow animal in England until the end of the eighteenth century. Remains of ancient art show conclusively that, long after domestication of the horse, the ox and the camel continued as the main source of agricultural power and transportation, respectively.

It is interesting to note that heavier draft-type animals had their development primarily in those countries in which Caesar campaigned in western Europe, including England. Doubtlessly, the improved roads that the Romans constructed during their long occupation were largely instrumental in encouraging the breeding of heavier horses capable of drawing heavier loads. The Great Horse served as the progenitor of the draft horse of agriculture.

INTRODUCTION OF HORSES AND MULES TO AND EARLY HISTORY IN THE UNITED STATES

It has been established that most of the evolution of the horse took place in the Americas, but this animal was extinct in the Western World at the time of Columbus' discovery, and apparently extinct even before the arrival of the Red Man, some thousands of years earlier.

Columbus first brought horses to the West Indies on his second voyage in 1493. Cortez brought Spanish horses with him to the New World in 1519 when he landed in Mexico (sixteen animals were in the initial contingent, but approximately 1,000 head more were subsequently imported during the two-year conquest of Mexico). Horses were first brought directly to what is now the United States by DeSoto in the year 1539. Upon his vessels he had 237 horses. These animals traveled with the army of the explorer in the hazardous journey from the Everglades of Florida to the Ozarks of Missouri. Following DeSoto's death and burial in the upper Mississippi three years later, his followers returned by boats down the Mississippi, abandoning many of their horses.

One year following DeSoto's landing in what is now Florida in 1540, another Spanish explorer, Coronado, started an expedition with an armed band of horsemen from Mexico, penetrating to a point near the boundary of Kansas and Nebraska.

Beginning about 1600, the Spaniards established a chain of Christian missions among the Indians in the New World. This

of missions extended from the eastern coast of Mexico up Rio Grande, thence across the mountains to the Pacific Coast. mission brought animals from the mother country, includ- horses.

There are two schools of thought relative to the source of oundation stock of the first horses of the American Indians, he hardy bands of mustangs—the feral horses of the Great s. Most historians agree that both groups were descended animals of Spanish (Arabian) extraction. However, some nd that their foundation stock came from the abandoned stray horses of the expeditions of DeSoto and Coronado, eas others claim that they were obtained chiefly from Santa ncient Spanish mission founded in 1606. It is noteworthy that a Fe and other early Spanish missions were the source of ish-Longhorn cattle, thus lending credence to the theory the missions were the source of foundation horses for the n and the wild bands of mustangs.

Much romance and adventure is connected with the mustang, ach band of wild horses was credited with leadership by the wonderful stallion ever beheld by man. Many were captured, he real leaders were always alleged to have escaped by reason eed, such as not possessed by a domesticated horse. The mus- multiplied at a prodigious rate. In one high luxuriant bunch- s region in the state of Washington, wild horses thrived so that the region became known as "horse heaven," a name ars even today.

The coming of the horse among the Indians increased the e and wars between tribes. Following the buffalo on horse- led to greater infringement upon each other's hunting nds, which had ever been a cause for war. From the time the ans came into possession of horses until the country was n over by the white man, there was no peace among the es.

Later, animals of both light- and draft-horse breeding were oduced from Europe by the colonist. For many years, how- , sturdy oxen continued to draw the plows for turning the on many a rugged New England hillside. Horses were largely as pack animals, for riding, and later for pulling wagons stagecoaches. It was not until about 1840 that the buggy first e its appearance.

Six mares and two stallions were brought to Jamestown in , these being the first European importations. Some of these

animals may have been eaten during the period of near starvation at Jamestown, but importations continued; and it was reported in 1611 that a total of seventeen horses and mares had been brought to this colony.

The horse seems to have been much neglected in early New England, as compared with cattle and sheep. This is not surprising, inasmuch as oxen were universally used for draft purposes. Roads were few in number; speed was not essential; and the horse had no meat value like that of cattle. Because of the great difficulty in herding horses on the commons, they were usually hobbled. Despite the limited early-day use of the horse, the colonist must have loved them, because, very early, the indiscriminate running of stallions among the mares upon the commons was recognized as undesirable. Massachusetts, before 1700, excluded from town commons all stallions "under fourteen hands high and not of comely proportion."[1]

Even before horses found much use in New England, they became valuable for export purposes to the West Indies for work in the sugar mills. In fact, this business became so lucrative that horse stealing became a common offense in New England in the eighteenth century. Confiscation of property, public whippings, and banishment from the colony constituted the common punishments for a horse thief.

As plantations materialized in Virginia, the need for easy-riding saddle horses developed, so that the owners might survey their broad estates. Racing also became a popular sport among the Cavaliers in Virginia, Maryland, and the Carolinas—with the heat races up to four miles being common events. The plantation owners took considerable pride in having animals worthy of wearing their colors. So great was the desire to win that by 1730 the importation of English race horses began.

George Washington maintained an extensive horse- and mule-breeding establishment at Mount Vernon. The President was also an ardent race fan, and riding to hounds was a favorite sport with him. As soon as Washington's views on the subject of mules became known abroad, he received some valuable breeding stock through gifts. In 1787, the Marquis de Lafayette presented him with a jack and some jennets of the Maltese breed. The jack, named Knight of Malta, was described as a superb ar-

[1] Thompson, James Westfall, History of Livestock Raising in the United States, 1607-1860, U. S. Dept. of Agri., Agricultural History Series No. 5, Nov., 1942.

of a black color, with the form of a stag and the ferocity of ger. In 1795, the King of Spain gave Washington a jack and jennets that were selected from the royal stud at Madrid. Spanish jack, known as Royal Gift, was sixteen hands high, gray color, heavily made, and of a sluggish disposition. It said that Washington was able to combine the best qualities ne two gift jacks, especially through one of the descendants ed Compound. General Washington was the first to produce es of quality in this country, and soon the fame of these ly hybrids spread throughout the South.

The Dutch, Puritan, and Quaker colonists to the north ad- d strictly to agricultural pursuits, frowning upon horse races. imported heavier types of horses. In Pennsylvania, under guidance of William Penn, the farmers prospered. Soon their es began to improve, even as the appearance and fertility heir farms had done. Eventually, these large horses were ned to enormous wagons and used to transport freight over- to and from river flatboats and barges along the Ohio, berland, Tennessee, and Mississippi rivers. Both horses and



Fig. 327. Conestoga freight wagon drawn by six Conestoga horses, in t of a country inn. These improved horses and large wagons were both n the name Conestoga, after the Conestoga Valley, a German settlement ennsylvania. The advent of the railroads drove the Conestoga horses oblivion, and the Conestoga wagon was succeeded by the "prairie oner." (Courtesy, The Bettmann Archive.)

wagons were given the name Conestoga, after the Conestoga Valley, a German settlement in Pennsylvania. The Conestoga wagon was the forerunner of the "prairie schooner," and before the advent of the railroad it was the freight vehicle of the time. It was usually drawn by a team of six magnificent Conestoga horses, which animals were well groomed and expensively harnessed. At one time, the Conestoga horses bid to become a new breed—a truly American creation. However, the railroads replaced them, eventually driving them into permanent oblivion. Other breeds were later developed, but this is another story.

GROWTH AND DECLINE OF UNITED STATES HORSE AND MULE PRODUCTION

The number of horses in the United States increased up to 1915, at which time there was a record number of 21,431,000 head. Horse production expanded with a growth and development of farms. The regular and marked recession in numbers after 1915, may be attributed to a lessened amount of new agricultural land brought under cultivation and, more important, the advent of mechanized power, including the tractor, truck, and automobile.

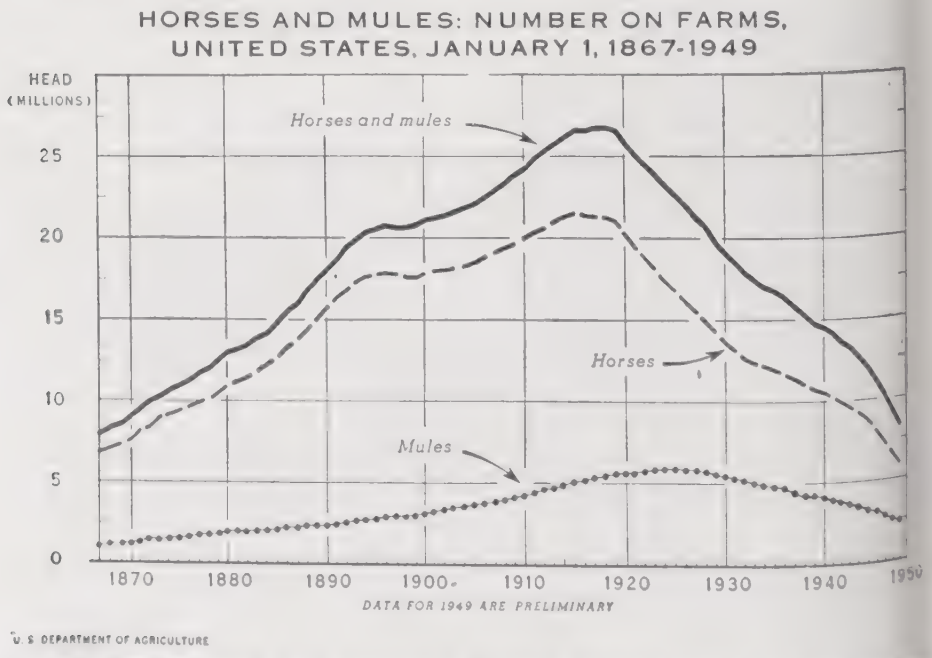


Fig. 328. Growth and decline of United States horse and mule production. Horse numbers reached a peak in 1915, whereas mule numbers reached a peak in 1925. The period of decline in horse and mule numbers coincides closely with the advent of mechanized power, especially the tractor, truck, and automobile. (Courtesy, U.S.D.A., Bureau of Agricultural Economics.)

On the other hand, mules on farms slowly but steadily eased in numbers for ten years after horses began their ne, reaching a peak in 1925 at 5,918,000 head. Mule numbers decreased proportionally less than horses because of their t use in the deep South where labor has been cheaper and abundant and the farms average smaller in size.

On January 1, 1949, there were 5,921,000 head of horses and ,000 head of mules in the United States, representing the st total numbers of these animals since 1867.

STORY OF HORSES AND MULES ORLD WAR II

Though declining in numbers and considered "old fashioned" hose persons who are enthralled by the speed of the machine the horse—man's good friend and stout companion through ges—dramatically proved his worth again and again on the of battle and on our farms during World War II.

Once the bulwark of armies—its numbers often deciding the s of conflict—the horse in World War II was practically



Fig. 329. Pack mules and "mule skinners" in service during World II. Horses and mules dramatically proved their worth again and again e field of battle and on our farms during World War II. (U. S. Army o.)

jeeped, tanked, and trucked out of his long-held place of importance in military history. Despite the unparalleled mechanization, however, horses played an indispensable role on many fronts during the recent great struggle for freedom. It is an old cavalry axiom that a horse can go wherever a man can travel, a feat which even the Army's famous little jeep could not accomplish.

The use of horses in World War II reached its greatest proportions in the Russian Army. Long famous for its Cossacks and centuries of cavalry tradition, Russia had in 1940 about 200,000 horses in cavalry and 800,000 more in artillery, draft, and pack. It is also estimated that Russia had two mounted armies available for combat. The Russian cavalry is credited with playing a decisive role in the defense of both Moscow and Stalingrad—striking swift, devastating blows, then quickly withdrawing and melting into the forests and countryside. The full story of the role played by the Russian Cossacks may never be known.

Germany and Japan also recognized the place of the horse in modern warfare. According to the most reliable sources available, the Germans at one time had 50,000 horses for cavalry use and approximately 910,000 draft and pack animals. The Japanese—constantly building up their horse units in China, where large areas were prohibitive to motor vehicles—probably had a cavalry force of 50,000 horses with an additional 300,000 in use for draft and pack purposes.

The United States Army had relatively few horses during World War II—only about 25,000 for cavalry use and 12,000 for draft and pack—but these units performed magnificently in combat. The 26th Cavalry fought a brilliant delaying action on Luzon; and both horses and mules were used in the Burma and Italian campaigns, which were conducted through jungles and over mountains where no vehicle of any sort could go.

On the civilian front, the contributions of horses and mules, though less spectacular than on the field of battle, were none the less substantial. Though statistics show a continued gradual but steady decline in horse and mule numbers throughout the war years, perhaps figures alone do not tell the true story. With the rationing of critical rubber and gasoline, the diverting of iron and steel to war production, and the consequent shortage of equipment—all resulting in a scarcity of mechanized power—there is little doubt that the horses and mules on farms in the United States were utilized to the maximum to help carry the major load of farm production.

During the five war years, 1941 to 1945, the total number orses on farms declined 13.5 per cent below the average of to 1940.

In summary, it may be said that the relentless wheels of ress are steadily lifting from the horse—that faithful beast urden—his role in both agriculture and war. But the horse t being relegated to permanent oblivion. Instead, he is rising more happy position in contributing to the fields of recrea- and sport.

CHAPTER XXXIV

DISTRIBUTION, ADAPTATION, AND THE FUTURE OF THE HORSE AND MULE INDUSTRY

Since prehistoric times, there has been nearly world wide distribution of the horse. Moreover, man's effective use of the horse has constantly progressed, especially from the standpoint of improvement in the equipment to which he was attached for the purpose of drawing loads. The past has been good, but even ardent horsemen recognize the passing of the horse as a source of power. For the most part, his brightest future lies in the fields of recreation and sport and as the cow pony of the West.

WORLD DISTRIBUTION OF HORSES AND MULES

After the horse was domesticated and no longer hunted down and killed for meat, he was used to carry riders and support goods upon his strong back. In an effort to provide transportation for a longer load than could be fastened directly to the back of the horse, ingenious man devised a basket-like arrangement which was fitted between two long poles. One end of these poles rested on the back of the horse and the other end dragged on the ground to the rear. In an effort to reduce the resistance of this vehicle and permit the carrying of still heavier loads, man supported the poles on a wooden axle and two wheels made of wood, thus inventing a two-wheeled cart. Next leather harness was developed, transferring the pull from the back of the horse to the better-adapted shoulders. Finally, man developed the four-wheeled, self-supporting vehicle with improved axles made of iron instead of wood; and eventually he replaced steel wheels with pneumatic tires mounted on ball bearings.

At a very early date and throughout the world, the versatility and adaptation of the horse was recognized. He was unexcelled in carrying a rider comfortably and swiftly on a long journey, he possessed a long life of usefulness; and, above all, he was intelligent. Despite all these virtues, in some areas the horse has been unable to replace the patient "roughage-burning" ox, and to this day oxen and water buffaloes are the chief source of power in many sections of the world. In the more isolated portions of the New England states of this country, many oxen are still used

TABLE 67

SIZE AND DENSITY OF HORSE POPULATION OF TEN LEADING HORSE-PRODUCING COUNTRIES OF THE WORLD, BY RANK

Country	Number of horses[1] (thousands)	When estimated[2]	Human population[3] (thousands)	Horses per capita	Area[3] (thousand) (square miles)	Horses per square mile
Russia	10,058	1946	182,364	0.06	9,442	1.1
Argentina	7,500	1946	16,000	0.47	1,113	6.7
United States	6,607	1948	142,656	0.05	3,620	1.8
Brazil	6,149	Av. 1934-38	48,000	0.13	3,300	1.9
Canada	2,397	1946	12,307	0.19	3,700	0.6
France	2,257	1946	40,830	0.06	213	10.6
Germany	2,204	1946	66,000	0.03	137	16.1
India	2,200	1946	365,900[4]	*	1,575[4]	1.4
Rumania	2,086	Av. 1934-38	20,045	0.10	114[4]	18.3
China	2,055	1946	491,000	*	4,457	0.5
World Total	75,200	1946	2,170,200	0.03	51,235	1.5

[1] *Foreign Agriculture Circular*, U. S. Dept. of Agri., August 18, 1947.

[2] Estimates for 1946 and 1948 are preliminary.

[3] J. Whitaker, *Whitaker's Almanac for 1948*, London, England, 1947, pp. 193-198.

[4] *The Economic Almanac for 1948*, National Industrial Council Board, New York, N. Y., 1947, pp. 1-5 and 264.

* Less than 0.01.

and stone boat pulling contests are a great attraction at the New England fairs.

Members of the ass family, mules and donkeys, are distributed in the warmer regions of the world. Like the horse and the ox, they are used for both pack and draft purposes.

Table 67 shows the size and density of horse population of the important horse countries of the world. According to the best available data, world horse numbers in 1946 totaled 75.2 million head. This is far below the 1934-38 average of 94.7 million head, representing 19.5 million head or 21 per cent less animals. The decline in horse numbers during the 1938-46 period can be attributed chiefly to mechanization of agriculture in certain areas and wartime losses in the war-devastated areas.

HORSE AND MULE PRODUCTION IN THE UNITED STATES

The sharp decrease in the number of horses and mules in the United States during the last three decades has had a serious



Fig. 330. Horse-drawn covered wagons. This photograph was taken when making the film for the "Covered Wagon," founded on Emerson Hughes' novel of the same name. When the news was spread that gold had been discovered in California, the Oregon Trail split in half, one part branching off to the south while the other part turned north toward Oregon. Improved roads and the advent of the motor vehicle have practically eliminated horses from the highways and city streets. (From Ewing Galloway.)

far-reaching effect upon American agriculture—and indirect-
on all industry. In 1920, there were 25,199,552 horses and
s on farms and ranches in the United States and about an
tional 2,000,000 head in cities; whereas on January 1, 1949,
e was a total of 8,274,000 head, with practically none remain-
on city streets. During the twenty-nine-year period, there
a decrease of 16,925,522 head, with total horse and mule
bers the lowest since the Civil War. Naturally, the explana-
of this marked decrease is the invasion of the automobile,
or, truck and improved heavy farm machinery; and in point
me, the decrease in horses has closely followed the introduc-
of such machinery.

This decrease in the work stock of the country was a con-
rable factor in the overproduction problem which confronted
rican agriculture prior to World War II. It has been variously
nated that from 35,000,000 to 75,000,000 acres of land that
herly produced feed for horses was released for other pur-
s. Using the upper limits of these estimates, this surplus
luction represents an area twice the size of the state of
ois.

ding States in Horse and Mule Production

On January 1, 1948, the ten leading states, by rank, in horse
mule numbers were as shown in Table 68. Without doubt,

TABLE 68

TEN LEADING STATES, BY RANK, IN HORSE AND MULE NUMBERS, 1948, WITH AVERAGE FOR 1943-1947[1]

te	Average 1943-1947 (thousand)	1948 (thousand)	State	Average 1943-1947 (thousand)	1948 (thousand)
	HORSES			MULES	
xas	530	440	Mississippi	335	306
ssouri	496	428	North Carolina	289	269
wa	542	346	Georgia	283	257
nnesota	488	345	Tennessee	267	234
braska	409	301	Alabama	262	222
isconsin	410	300	Texas	333	191
klahoma	326	257	Kentucky	199	171
inois	387	249	Arkansas	224	165
ansas	342	246	South Carolina	166	157
uth Dakota	301	219	Louisiana	157	136
tal nited States	8,563	6,589	Total United States	3,213	2,541

[1] *Livestock Market News Statistics and Related Data*, 1947, U. S. t. of Agri., July, 1948, p. 3.
Agricultural Statistics, U. S. Dept. of Agri., 1949, pp. 405-406.

Texas leads in horse numbers because of: (1) a preponderance of ranching in the state, a condition which necessitates the cow pony, for which a suitable mechanical substitution has not been found; and (2) the great size of the Lone Star State. The other leading horse states embrace the farming territory of central United States, in and near the Corn Belt.

The most dense mule population continues, as always, to be confined to the South and Southeast, areas characterized by a warm climate, extensive cotton and sugar cane plantations, and an abundance of cheap labor. Over 80 per cent of the mules in the United States are located in the South Atlantic and south central states, an area extending from the western border of Texas to the Atlantic Coast. The southern states have more mules than horses. Only a very negligible number of mules are to be found in New York and New England. In fact, the creature is almost a novelty in these sections. Likewise very few mules are used on the ranges of the far West.

Despite the serious reduction in horse and mule numbers, it is interesting to note that most farms and ranches own one or more horses or mules. In 1940 about 72 per cent of our farms had either horses or mules or both (horses were reported on 52[1] per cent of the farms and mules on 30[1] per cent). Horses or mules are found on more farms than sheep or hogs, but they are less widely distributed than chickens or cattle.

HORSES VERSUS MECHANICAL POWER

Ironical as it may seem, the development of manufacturing and commerce has been responsible for both the rise and fall of the horse and mule industry of the United States. The early growth of American industry created a large need for horses to transport the raw and manufactured goods and to produce needed agricultural products for those people who lived in the cities and villages. With further scientific developments—especially the invention of the tractor, truck, and automobile—the horse was replaced, first ever so slowly but then rapidly and drastically. Between 1920 and 1930, there was an increase of 674,000 tractors, 761,000 motor trucks, and 1,938,000 automobiles on the farms and ranches of the United States. These increases were associated with a decline of 3,711,000 horses and mules over two years of age. Between 1930 and 1937, there was a further decline of 3,525,000 horses and mules over two years of age.

[1] The sum of these two figures is not 72, because some farms have both horses and mules.

Over a period of time, mechanical power has been perfected
n the standpoint of durability, versatility, and ease and econ-
of operation. No doubt further progress along these lines
ahead. Even so, there are some advantages to horse and mule
n power, especially under certain conditions that are not to
verlooked. In the final analysis, then, perhaps the choice of
power should remain a matter for individual consideration.



Fig. 331. One-horse rake. Power equipment is fast eliminating such time familiar farm scenes. (Courtesy, University of Massachusetts.)

r a long period of years farmers will adopt that source of
er that is consistent with good practice and which proves the
st profitable.

Today, only a sprinkling of horses are found on city streets.
e old-time livery stable has long since passed out of existence;
ft horses are seldom hitched to large dray wagons; mounted
police are almost a novelty; and only a sprinkling of horses
ear on delivery wagons.

E FUTURE OF THE HORSE AND MULE INDUSTRY

Most people agree, horse lovers among them, that further
lines in work horse and mule numbers are inevitable. But
need to take stock of our gasoline and oil supplies. Should
re be another war, perhaps the retention of a goodly number
horses and mules might be in the nature of preparedness. In
final analysis, however, the dominant factors that will de-

termine the future of the horse and mule situation are: (1) the amount of mechanization, (2) the need for the cow pony, and (3) the use of horses for recreation and sport.

Further Mechanization Inevitable

We now live in an atomic age. Certainly, further mechanization in this era is inevitable. Some manufacturers even go so far as to predict that it is only a matter of time when the farm horse will be driven into permanent oblivion. In the thinking of these machine enthusiasts, this time only awaits the ingenuity of man in perfecting more and better adapted machines that will operate with greater economy.

Draft horse numbers will probably decline more rapidly than mule numbers. With cheaper sources of both labor and feed, it is quite likely that the South will continue to use a sizeable number of mules for many years to come.

The Cow Pony of the West

The 500,000 horses in the 17 western range states are nearly holding their own. Even the Army's famous little jeep does not



Fig. 332. The cow pony of the West will continue to furnish needed assistance in handling the range herds. Shown is Poco Bueno, Quarter Horse stallion owned by Three D Stock Farm, Arlington, Texas. (Courtesy, The Quarter Horse Journal.)

ear sufficiently versatile for use in roping a steer on the ge. It is reasonable to assume, therefore, that the cow pony continue to furnish needed assistance to man in the far West.

ses For Recreation and Sport

Throughout the nation, there appears to be a renewed rest in light horses. More than ever the horse is here for reation and sport. Although the mechanical age is with us, horse is still the show. The bridle paths in the city parks are



Fig. 333. More than ever the horse is here for recreation and sport. wn are two riders on a trail in Cook County, Illinois. (Courtesy, Horse sociation of America.)

ng lengthened each year; the race crowds are bigger than r; the game of polo has expanded; riding to hounds has ared its glamour with greater numbers; and people of all walks life enjoy the great horse shows throughout the land.

Back in 1918, there were an estimated 150,000 light horses the United States, representing less than 1 per cent of the rse population of the time; whereas, in 1950, there were an imated 2,000,000 head of light horses, representing between and 30 per cent of the total horse population. Thus, in 1950, re were in this country more than 13 times as many light rses as there were in 1918.

Less encouraging to light horse enthusiasts, however, is the lack of interest in horses on the part of the United States Army in this atomic age. The Remount Service, which was established by Act of Congress in 1921, was transferred to the United States Department of Agriculture on July 1, 1948, following which a gradual liquidation of the program was initiated. At the time of the transfer, approximately seven hundred remount stallions were in service throughout the country.

CHAPTER XXXV

TYPES AND CLASSES OF LIGHT HORSES ACCORDING TO USE

In no class of animals have so many diverse and distinct s been developed as in the horse. The descendants of the ıtal light-legged horses have, for generations, been bred and for riding and driving purposes—first as the chariot and g horses of Egypt, Greece, and Arabia; later as the running e of England; and finally for purposes of recreation and t in the United States and throughout the world. In due time, ıer refinements in breeding light horses were made, and e animals were adapted for more specific purposes. In this ner, light horses specifically adapted to the purposes enumed in Table 69 have evolved.

In attempting to produce animals to meet these specific purs, new breeds of light horses have been developed. In certain s, however, the particular use or performance is so exacting only one breed appears to be sufficiently specialized; for ıple, in running races the Thoroughbred is used exclusively, harness races are now synonomous with the Standardbred d.

ING HORSES

Riding horses have many and varied uses, but, as the name eates, they are all ridden. They may have a very definite ty value, as is true of stock horses, or they may be used fly for purposes of recreation and sport. For the latter use, ıing, manners, and style are of paramount importance, algh durability and efficiency are not to be overlooked in any e.

ee- and five-gaited saddle horses

Long after the development of the New England town, the ing up of roads along the eastern seaboard, and the develop- t of the buggy and the popularity of the roadster type of e, the states of Virginia, West Virginia, Kentucky, Tennes- and Missouri still consisted of large plantations under the ership of southern gentlemen. Roads were few and far be- en, and travel was largely on horseback over the most natural

TABLE 69

LIGHT HORSE SUMMARY

Type	Use	Breeds	Height	Weight	Place of origin
			(Hands)	(Pounds)	
Riding Horses	Three- & Five- gaited saddle horses	American Saddle Horses	14-2 to 17	900-1,400	United States
		Thoroughbred			England
		Arabian			Arabia
		Morgan			United States
		Palomino			United States
		Pinto			United States
	Plantation walking horses	Tennessee Walking Horse	15 to 16	1,000-1,200	United States
	Stock Horses	Grades, crossbreds, or following purebreds:			
		Throughbred	15 to 15-1	1,000-1,100	England
		Quarter Horse			United States
		Morgan			United States
		Arabian			Arabia
		Palomino			United States
		Pinto			United States
		Appaloosa			United States
	Polo Mounts	Grades, crossbreds, and purebreds of all breeds	14-2 to 15	1,000-1,250	
	Hunters	but predominantly of Thoroughbred breeding	15-2 to 16-2	1,000-1,250	
Race	Running race horses	Thoroughbred	15-1 to 16-2	900-1,150	England
	Harness race horses (trotters and pacers)	Standardbred	14-2 to 15-2	900-1,200	United States
	Quarter race horses	Quarter horses	14-2 to 15-2	1,000-1,200	United States
Driving Horses	Heavy Harness Horses	Hackney	14-2 to 16-1	900-1,300	England
		Cleveland Bay			England
		Yorkshire Coach			England
		French Coach			France
		German Coach			Germany
	Fine Harness Horses	American Saddle Horses (Predominantly, although other breeds are so used)	14-2 to 17	900-1,400	United States
	Roadsters	Standardbred	14-2 to 15-2	900-1,200	United States
		Morgan			United States
	Ponies for driving	Hackney	9 to 14-2	500-900	England
		Welsh			England
		Shetland			Shetland Isles
Ponies	Riding	Hackney	9 to 14-2	500-900	England
		Welsh			England
		Shetland			Shetland Isles

paths that could be found. Thus there was need for a horse that would carry the plantation owners with dignity befitting their station in life and with the least distress possible to both rider and horse. As the plantation owners rode over their broad estates, easy gaits were a necessity. Such was the need, and out of this need arose the beautiful American Saddle Horse.

Animals qualifying as either three- or five-gaited saddle horses in the leading American horse shows are predominantly of American Saddle Horse breeding, a truly American creation. Occasionally, however, animals of the other light horse breeds are trained to execute the five gaits. It must also be remembered that the vast majority of American horses of all breeds are

hree-gaited variety and that only a relatively small propor- of these animals are ever exhibited. Instead, most of the e-gaited horses are used for utility purposes and pleasure g.

The gaits of the three-gaited horses are: the walk, the trot, the canter. In addition to performing these same gaits, the gaited horse must possess a "slow gait" and the rack or e-foot. The "slow gait" may be either the running-walk, fox- or stepping pace (slow pace), with the latter slow gait pre- d.

Whether an animal is three-gaited or five-gaited is primarily ıter of training. Custom decrees that three-gaited horses be n with their manes "hogged" or clipped short and their tails ked" or shaved for a short distance from the base; whereas



Fig. 234. Wing Commander, World's Grand Champion five-gaited Ameri- Saddle Horse, 1948-49-50-51, bred and owned by Mrs. Frederick L. Lennep, Dodge Stables, Castleton Farm, Lexington, Kentucky. Wing mander, presented here in his trot, is 15-2 hands in height and weighs pounds. Note his superb style and type. True to custom for five-gaited s, Wing Commander is shown with flowing mane and full-length tail. rtesy, The National Horseman, Louisville, Kentucky.)

five-gaited horses are shown with flowing mane and full-length tails.

In addition to executing the gaits with perfection, both three- and five-gaited animals should possess the following characteristics:

1. **Conformation,** in which the principal requirements are:
 (1) Graceful lines obtained through a fairly long, arched neck; short, strong back and loin with a good seat; a nicely turned croup; a smartly carried, flowing tail, and a relatively long underline.
 (2) A shapely and smart head.



Fig. 335. Captain's Model, a weanling American Saddle Horse filly, bred by C. J. Cronan, Jr., Louisville, Kentucky. Whether an animal of American Saddle Horse breeding is three-gaited or five-gaited is primarily a matter of training. (Courtesy, American Saddle Horse Breeders Association.)

(3) Nicely sloping shoulders and pasterns.
(4) Symmetry and blending of all parts.
(5) Quality, as evidenced by a clean-cut, chiseled appearance throughout and soundness.
(6) Style, alertness, and animation, sometimes said to be comparable to that of a "peacock."

2. **Perfectly mannered,** which includes form, training, and lience — those qualities that make for a most finished ormance.

3. **Superior action,** including an elastic step, high action, evidence of spirit and dash in action.



Fig. 336. The Plantation Walking Horse, Midnight Sun, owned by Harale Farm, Franklin, Tennessee. This horse was twice World's Grand npion Tennessee Walking Horse. Plantation Walking Horses are largely rised of the Tennessee Walking Horse breed. (Courtesy, Harlinsdale n.)

tation Walking Horses

This particular class of horses is largely comprised of one d: the Tennessee Walking Horse.[1]

Horses of this type were first introduced into Tennessee by early settlers from Virginia and the Carolinas. For many

[1] A more detailed description of this and other breeds may be found in ter XXXVII.

years, the plantation owners of middle Tennessee—men who spent long hours daily in supervising labor from the saddle—selected and bred animals for their easy, springy gaits, good dispositions, and intelligence. Particular stress was placed upon the natural gait known as the "running-walk" and upon the elimination of the trot. Thus, the three gaits that evolved in the plantation walking horse are: the walk, the running-walk, and the canter. In animals of this type, the head is somewhat low in carriage, and at the running-walk there is a characteristic nodding of the head. Sometimes there is also a flopping of the ears and a snapping of the teeth while the animal is in this rhythmic movement. Plantation horses are also noted for their wonderful dispositions. Their easy gaits and a superb disposition make them an ideal type of horse for the amateur rider or the professional or society person who rides infrequently.

Stock horses

Stock horses constitute the largest single class of light horses in this country; there are approximately 500,000 of them in use in the seventeen range states. They are the "cow ponies" of the West.

Usually, stock horses are of mixed breeding. Most generally they are descended from the Mustang—the feral horse of the



Fig. 337. Woodie, stock horse owned and ridden by Milt Bennett, cuts a calf away from the herd. Stock horses constitute the largest single class of light horses in this country. (Courtesy, Horse Association of America)

ed States. Subsequently, Mustang mares have been mated to s of practically every known light horse breed—especially roughbreds and Quarter horses. Stallions of the Palomino, gan, Arabian and other breeds have also been used. Such grad- up has improved the size, speed, and perhaps the appearance he "cow pony," but most horsemen will concede that no mix- of breeds will ever produce a gamier, hardier, and more en- ng animal than the Mustang. In addition to being game and ly, the stock horse must be agile, sure-footed, fast, short bled, deep, powerfully muscled, durable, and must possess good and legs. Above all, the cowboy insists that his pony be a good panion and that he possess "cow sense."

Mounts

As the name would indicate, polo mounts include that type class of horses particularly adapted for use in playing the e of polo. This game, which was first introduced into this



Fig. 338. Belle Of All, one of the most famous polo mounts that ever ed at Meadowbrook, Long Island. Note the pronounced Thoroughbred . Polo ponies must be quick and clever in turning, and they must be able odge, swerve, or wheel while on a dead run. (Courtesy, Horse Associa- of America.)

country in 1876, is played by four mounted men on each team. The object is to drive a wooden ball between goal posts at either end of a playing field 300 yards long and 120 to 150 yards wide. Long-handled regulation mallets are used to drive the ball.

At the time the game was first introduced into the United States, ponies were limited to 13-2 hands in height. Later, the height restriction was raised to 14-2 hands, and more recently, animals up to 15-2 have been accepted.

Although very similar to the hunter in type, the polo mount is smaller in size. He must be quick and clever in turning, and he must be able to dodge, swerve, or wheel while on a dead run. He must like the game and be able to follow the ball.

The polo mount is trained to respond to the pressure of the reins on the neck, so that the rider may be free to guide him with only one hand. Up to five or six years is required to complete the schooling of a polo horse, and as many as four to six mounts may be used by each player in a single game—all of which contributes to the expensiveness of the sport.

Polo ponies are usually of mixed breeding, but most of them are predominantly Thoroughbred. Type and training, together with native ability and intelligence, are the primary requisites.

Hunters

The hunter is that type of horse used in following hounds in fox hunting. The sport is traditional in England, and each year it is sharing its glamour with greater numbers in the United States.

Again the hunter is not necessarily of any particular breeding, but Thoroughbred blood predominates. The infusion of some cold blood (draft breeding) is often relied upon in order to secure greater size and a more tractable disposition.

Hunters are classified as light, medium, and heavy weight. The first of these carry a rider weighing under 165 pounds; the medium weight hunters are expected to carry weights ranging from 165 to 190 pounds; and the heavy weight animals carry 190 pounds or over. As many folks who ride to hounds do so in order to keep down their weight, their need for a sizeable mount can be fully appreciated. It must also be realized that a 5-foot object is 4 inches lower for a 16-hand horse than for one only 15 hands in height. Hunters are further classified as "green" or "qualified," the latter having hunted one season with a pack recognized by the United Hunts and Steeple Chase Association.

In addition to being of ample size and height, the hunter possess the necessary stamina and conformation to keep with the pack. He must be able to hurdle with safety such non field obstacles as fences and ditches. The good hunter, efore, is rugged, short coupled, and heavily muscled ughout.



Fig. 339. A jumper in action and well ridden. This is also a good type er. All hunters are jumpers to some degree, but a high jumper is not ssarily a good hunter. (Courtesy, Horse Association of America.)

All hunters are jumpers to some degree, but a high jumper ot necessarily a good hunter. To qualify as a hunter, the se must do more. He must execute many and varied jumps a long period of time.

alry mounts

In this atomic age it is not likely that large numbers of ses will be used by the Army. Yet, their necessity and useful- under certain conditions was well demonstrated in World II.

In type, cavalry mounts are identical to hunters and polo nts. They range in height from 15 hands to 16-1 and in



Fig. 340. Cavalry mounts in action during the time of the monsoons (rainy season) in the Burma campaign of World War II. (U. S. Army Photo.)

weight from 1,000 to 1,150 pounds. Army color specifications are limited to bay, brown, black, and chestnut, or sorrel.

RACE HORSES

According to some historians, the Greeks introduced horse racing in the Olympic games in 1450 B. C. Also, it is reported that a planned horse race of consequence was run in 1377 between animals owned by Richard Second and the Earl of Arundel. The sporting instinct of man being what it is, it is reasonable to surmise, however, that a bit of a contest was staged the first time that two proud mounted horsemen chanced to meet. Today, three types of horse races are run: (1) running races, (2) harness races, and (3) quarter races.

Running race horses

Race horses, used for running (an extended gallop) under the saddle, are now confined exclusively to one breed, the Thoroughbred. On the other hand, the Thoroughbred breed (in

ing both purebreds and crossbreds) has been used widely other purposes; especially as a stock horse, polo mount, er, and cavalry horse.

Although trials of speed had taken place between horses the earliest recorded history, the true and unmistakable dation of the Thoroughbred breed as such traces back only ne reign of Charles II, known as the "father of the British "



Fig. 341. Citation, sensational Thoroughbred, bred and owned by War- Wright, Calumet Farm, shown as a two-year-old. Citation, leading ey winner of the Thoroughbred breed, is the first million dollar winner, total turf earnings of $1,085,760. Running races under the saddle are confined exclusively to the Thoroughbred breed. (New York Racing ociation Photo.)

Although the length of race, weight carried, and type of k have undergone considerable variation in recent years, the ning horse always has been selected for speed and more ed at the run. The distinguishing characteristics of the run- g horse, as represented by the Thoroughbred, are the ex- ne refinement, oblique shoulders, well-made withers, heavily

muscled rear quarters, straight hind legs, and close travel to the ground.

Harness race horses (trotters and pacers)

Prior to the advent of improved roads and the automobile, but following the invention of the buggy, there was need for a fast, light-harness type of horse. This horse was used to draw vehicles varying in type from the light roadster of the young gallant to the dignified family carriage. In the process of meeting



Fig. 342. Greyhound, Standardbred harness race horse in action. He still holds the world's trotting record of 1:55¼ for the mile. With a stride exceeding 27 feet, Greyhound was often referred to as the "Silver Groomed Flyer." Trotters and pacers are of similar breeding and type, the particular gaits being largely a matter of training. Today, harness race horses are almost exclusively of the Standardbred breed. (Courtesy, United States Trotting Association.)

this need, two truly American breeds of horses evolved: the Morgan and the Standardbred. The first breed traces to the foundation sire, Justin Morgan; and the latter to Hambletonian 10, an animal which was line bred to imported Messenger.

As horse and buggy travel passed into permanent oblivion except for recreation and sport, the Standardbred breeders wisely placed greater emphasis upon the sport of racing; whereas the Morgan enthusiasts directed their breeding programs toward transforming their animals into a saddle breed.

The early descendants of Messenger were sent over the , trotting (not galloping) under the saddle; but eventually ockey races in this country came to be restricted to a run- type of race in which the Thoroughbred was used. With this qualifying standards—a mile in 2:30 at the trot and 2:25 e pace when hitched to the sulky—were set up for light ss races; and those animals so qualifying were registered.[1] neumatic-tire racing vehicles, known as sulkies, were first duced in 1892. With their use that year, the time was re- nearly four seconds below the record of the previous year. was developed harness racing and the Standardbred breed rses, which today is the exclusive breed used for this pur-

Trotters and pacers are of similar breeding and type, the cular gaits being largely a matter of training. In fact, many iduals show speed at both the trot and the pace.

The Standardbred breed—like the Thoroughbred—also finds uses — as driving horses in roadster classes, delivery s, and general utility farm horses. By way of comparison the Thoroughbred, the Standardbred possesses a more tract- disposition; is smaller, longer bodied, closer to the ground, er-limbed and sturdier in build. The latter characteristic is necessary because harness races are usually "heat races"— xample, the best two out of three races.

Horses of this type now find their principal use in harness at country and state fairs, although pari-mutuel harness g has been established at certain tracks. Today, harness horses are almost exclusively of the Standardbred breed.

ter race horses

Quarter racing has become an increasingly popular sport e West. For the most part, races of this type are confined nimals of the Quarter Horse breed, which animals derived name and initial fame for their extraordinary speed at nces up to a quarter of a mile. Although the great majority uarter Horses are used to work cattle and never appear on race track, the proponents of quarter racing advocate the race as a means of proving animals. Performance, so they argue, e proof of whether or not a horse can do the job for which he ed. Thus, quarter racing is used as a breed proving ground

[1] On January 1, 1933, registration on performance alone was no longer ed, and registration of both sire and dam was required. The qualify- tandards were initiated in 1879.

for the Quarter Horse, for in this racing the fundamental quality of speed can be measured accurately and recorded in such a way that the performance of horses in all parts of the country can be compared.

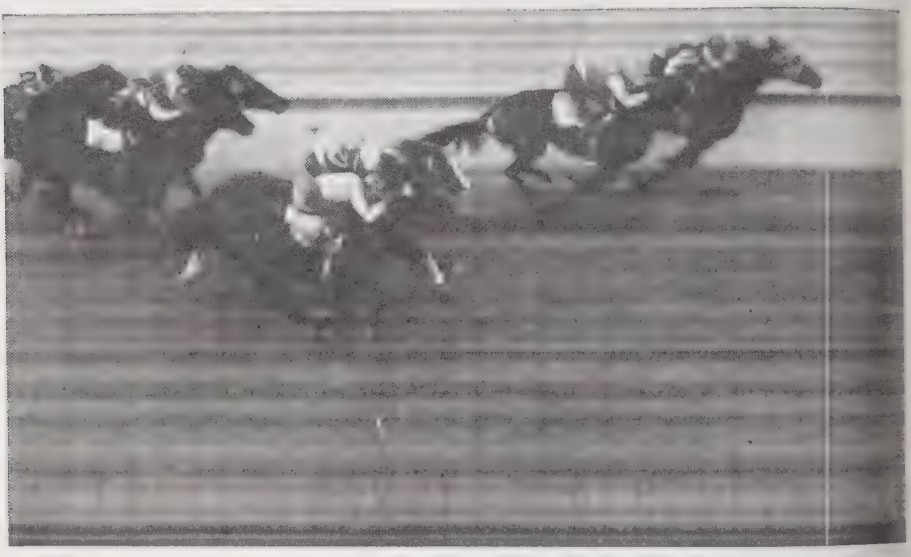


Fig. 343. Miss Panama shown winning the 1949 World's Championship Quarter at Tucson, Arizona. This race is to the quarter racing world what the Kentucky Derby is to thoroughbred racing. (Courtesy, Van A. Smelker, Jr., Secretary-Treasurer, American Quarter Racing Association.)

DRIVING HORSES

At the present time, driving horses are used chiefly for purposes of recreation. According to the specific use made of them, driving horses are classified as heavy harness horses, fine harness horses, roadsters, or ponies.

Heavy harness horses

These are also known as carriage horses. At the present time, this type of horse has very little place in the utility field, its use being largely confined to the show ring. As the name implies, the heavy harness horse of the show ring wears heavier leather than the roadster, though it in no way approaches draft harness. The heavy leather used on these animals was first decreed by fashion in England, the idea being that "to drive handsomely one must drive heavily." The vehicles drawn were heavy and logically and artistically the harness had to be in proportion thereto.

Heavy harness horses were especially popular during the Victorian era, and the ownership of a handsome pair was an in-

on of social prestige. In this country during the "gay es," bob-tailed hackneys attached to high-seated "rigs" a dashing picture as they pranced down the avenue.

t one time, there were several heavy harness breeds, but esent all except the Hackney have practically ceased to In this country, therefore, the Hackney is now the heavy ss breed.

he heavy harness horse should possess the following dis- shing characteristics:



ig. 344. Creation King, heavy harness horse in action. Creation King ational champion Hackney stallion for two years and winner of many championship classes. Bred and owned by Miss Iona and Harley Heyle, ington, Illinois. At the present time, the use of heavy harness horses gely confined to the show ring. (Courtesy, The National Horseman, ville, Kentucky.)

1. **Beauty**—obtained through graceful, curved lines; full- form; and high carriage. Show-ring style decrees that y harness horses be docked and have their manes pulled.

2. **High action**—animals of this type are bred for high hock knee action, but skilled training, bitting, and shoeing are ssary for their development.

3. **Manners and temperament**—perfection in the manners disposition of pleasure horses of this type is a requisite of rank.

4. **Color**—seal brown, brown, bay, and black colors are pre- d in heavy harness horses. White stockings are desired for urpose of accentuating high action.

Fine harness horses

In the show ring, fine harness horses are, according to the rules of the American Horse Shows Association, limited to the American Saddle Horse breed. In some shows, however, other breeds are exhibited in fine harness classes. Fashion decrees that fine harness horses shall be shown wearing long mane and tail, and drawing a four-wheeled road show wagon without top, or with top drawn. Light harness with a snaffle bit is required. Fine harness horses are shown at an animated park trot and at an animated walk.

Roadsters

The sport of showing a roadster originated in the horse and buggy era. It was founded upon the desire to own an attractive horse that possessed the necessary speed to pass any of his rivals encountered upon the city or country thoroughfares. In the show ring, roadsters are generally shown in either or both (1) roadster to bike, or (2) roadster to buggy classes. The latter are hitched singly or in pairs.



Fig. 345. Country Gentleman, Standardbred gelding shown here in a roadster to buggy class. Generally show classes are provided for (1) roadsters hitched singly, and (2) roadsters in pairs. Also most shows have a class for roadsters to a two-wheel bike. Roadsters are almost exclusively of Standardbred breeding. (Courtesy, The National Horseman, Louisville, Kentucky.)

Originally, roadster classes included animals of both Standred and Morgan extraction. In recent years, however, the gan has developed more in the direction of a saddler, leaving oadster classification almost exclusively to the Standardbred. In addition to possessing the usual Standardbred characters, particular stress is placed in roadster show classes upon manners, style, and beauty of conformation, combined with d. In striking contrast to heavy-harness classes, the roadster own hitched to very light vehicles permitting fast travel.

es for driving

As previously indicated, to classify as a pony, an animal be under 14-2 hands in height. Three breeds produce ani- that qualify under this category; namely, the Hackney, h, and Shetland breeds. The Hackney is generally exclu- y of the harness type, but the Welsh and Shetland breeds used either under the saddle or in harness. In the major e shows of the land, the latter two breeds may be exhibited rness, but in practical use they are children's mounts.



ig. 346. Bolgoed Mighty Atom, Champion Harness Show Pony. This ted grey Welsh Pony stallion stands 46½ inches high. Owned by horn Farms, Libertyville, Illinois. (Courtesy, American Shetland Pony al.)

Aside from their miniature size, ponies must be kind and gentle in disposition with as much spirit as is compatible with their use. The type and build will vary according to breed and proposed use.

PONIES FOR RIDING

The larger-sized ponies are really pocket editions of heavy-harness horses or little cobs. Shetland ponies are of two types: (1) a very small copy of a draft horse of good type, and (2) a more slender kind called the American type.

Ponies should possess the following characteristics: (1) gentleness, (2) sound feet and legs, (3) symmetry, (4) good eyes, (5) endurance, (6) intelligence, (7) patience, (8) faithfulness, and (9) hardiness.



Fig. 347. Three children on a Shetland pony. Note the stocky build of this pony. (Courtesy Horse Association of America.)

CHAPTER XXXVI

'ES AND CLASSES OF WORK HORSES AND MULES

As with light horses, similar distinct types—though smaller umber—evolved in the draft horse. From the ponderous beast 'landers, used as foundation stock, the Great War Horse of Middle Ages was developed; the Great War Horse, in turn, ed as the forerunner of the modern draft horse of commerce agriculture. Further and eventual refinement through breed- and selection adapted the draft animals to many and diverse , some of which have subsequently passed into oblivion with hanization. For example, expressers—fast-stepping, delivery- horses in great demand during the early part of the present ury—are now used to only a limited extent.

In the South and Southeast, where mules continue to furnish main source of power, certain distinct types of these animals also bred. The type of mule desired is largely controlled ough the selection of certain types of mares for breeding poses.

RK HORSES

At the present time, work horses are classified according to as: (1) draft horses, (2) wagon horses, (3) farm chunks, and southerners. Originally, classes for loggers and artillery ses were included, but these have been pretty much the ims of mechanization.

Although marked differences in size and weight exist be- en these various classes, all possess a deep, broad, compact scular form suited to the pulling of a heavy load at the walk. letailed description of a draft type animal is as follows: should have plenty of size, draftiness, and substance. The d should be shapely and clean cut, the eyes large and clear the ears active. The chest should be especially deep and of le width. The topline should include a short, strong back and , with a long, nicely turned and well-muscled croup, and a l-set tail. The middle should be wide and deep, and there uld be a good depth in both fore and rear flanks. Muscling uld be heavy throughout, especially in the forearm and gas- ; the shoulder should be sloping; the legs should be straight,

true, and squarely set; the bone should be strong and flat and show plenty of quality. The pasterns should be sloping and the feet large with width at the heels and toughness in conformation. With this splendid draft type, there should be style, balance, and symmetry; an abundance of quality; an energetic yet manageable disposition; soundness; and freedom from disease. The action should be straight and true, with a long, swift, and elastic stride both at the walk and the trot.

The market classification of work horses according to the use to which they are put and their range in height and weight is shown in Table 70.

TABLE 70

MARKET CLASSIFICATION OF WORK HORSES

Class	Range in height (in hands)	Range in weight (in pounds)
Draft horses	16 to 17-2	1600 upward
Wagon horses	15-2 to 16-2	1300-1600
Farm chunks	15 to 16	1300-1400
Southerners	14-2 to 15-2	600-1100

Draft Horses

Draft horses stand from 16 to 17-2 hands in height and weigh from 1,600 pounds upward. They represent the ultimate



Fig. 348. High quality draft horses drawing a plow. (Courtesy, Horse Association of America.)

ower type. The use of animals of this type is now largely ned to the farms of the central states. Formerly, draft-type es of quality and style were used on city streets, but these long since been replaced by trucks. Industry's most glamor- use of draft horses today consists of the "six-horse hitches" for exhibition—a type of advertising.

on Horses

Wagon horses are intermediate in weight and height between drafter and chunk but have more action than either. They h from 1,300 to 1,600 pounds and stand from 15-2 to 16-2



Fig. 349. Six-horse hitch of Shire horses on exhibition at the Western hington Fair, Puyallup, Washington. Horses owned and driven by Lou tuck, Horseshoe Ranch, Toppenish, Washington. (Courtesy, Lou Shat-)

ds in height. They usually have less depth of body and longer than draft horses and thus are better able to jog along at trot. Animals of this type still find limited use for delivery oses, especially on milk and laundry wagons. In addition to essing suitable conformation, wagon horses should have an active appearance to provide advertising value for the service hich they are used.

n Chunks

The term "chunk" is descriptive of the farm-chunk type of nals. They are "small-sized" drafters standing 15 to 16 hands eight and weighing from 1,300 to 1,400 pounds.

Southerners

Southerners are a smaller, plainer type of animal used in the South. Many of them are obtained from the western range states. They are used by the southern planters as a utility type of animal for tilling lands and for riding and driving. They usually stand from 14-2 to 15-2 hands and weigh from 600 to 1,100 pounds.

MULES

It has been correctly said that the mule is without pride of ancestry or hope of posterity. He is a hybrid, being a cross between two species of the family Equidae—the Caballus or horse and the Asinus or ass.[1] Like most hybrids, the mule is seldom fertile.

The use of the mule in the United States was first popularized by two early American statesmen, George Washington and Henry Clay. The first jack to enter this country, of which there is authentic record, was presented by the King of Spain to General Washington in 1787, shortly after the close of the Revolutionary War. Other importations followed; and from this day forward, the hardy mule has furnished the main source of animal power for the South. In comparison with the horse, the mule can: (1) withstand higher temperatures; (2) endure less experienced labor; (3) better adapt his eating habits to either irregularity or self-feeding with little danger of founder or digestive disturbances; (4) work or stable in lower areas without head injury (the mule lowers the head when the ears touch an object, whereas a horse will throw his head upward under similar conditions); (5) encounter less foot trouble, wire cuts, etc.; and (6) generally maneuver about without harm to himself.

Although the mule resembles his sire, the jack, more than the mare, the desired conformation is identical to that described for the horse; perhaps the one exception is that more stress is placed upon the size, set, and quality of the ear.The most desirable mules must be of good size and draftiness, compact, heavily muscled; must show evidence of plenty of quality; must stand on correct feet and legs; and must be sound. As the natural tendency of the mule is to be lazy and obstinate, an active, energetic disposition is sought.

[1]The cross between a jennet and a stallion is known as a hinny. The mule and the hinny are indistinguishable, but the hinny is seldom seen because of the greater value of jennets in producing jacks and jennets.

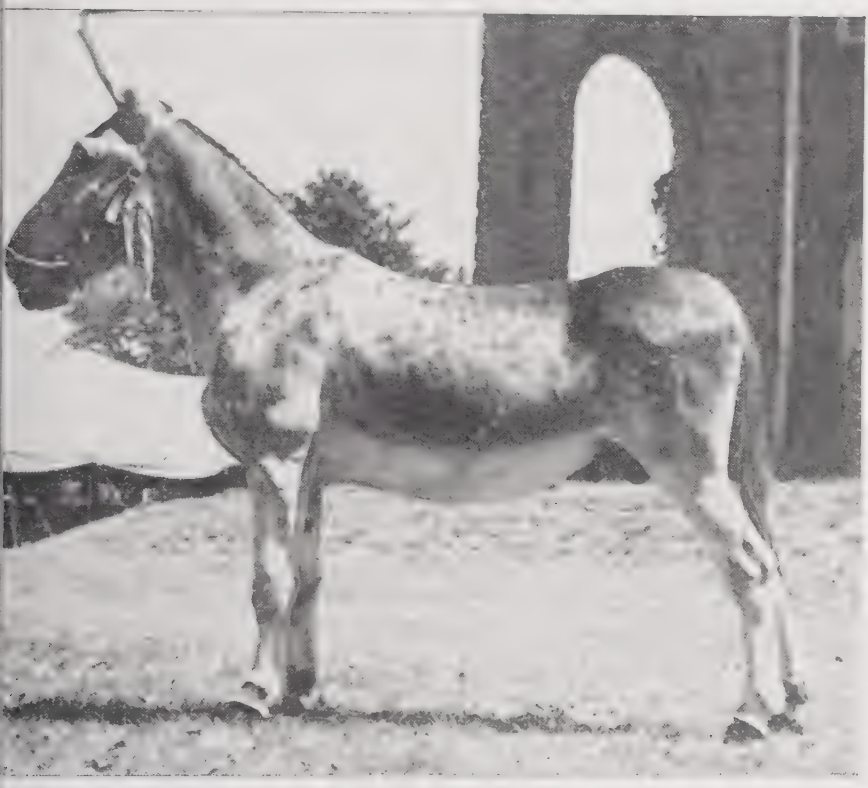


Fig. 350. Red Oak Chief, Grand Champion Jack of the 1946 Kansas, ouri, and Kentucky State Fairs. Note his heavy bone, well set legs, and head and ears. This jack is owned by Hineman's Jack Farms, Dighton, as. (Courtesy, Horse Association of America.)

The market classification of mules according to the use to h they are put, including range in height and weight, is n in Table 71.

TABLE 71

MARKET CLASSIFICATION OF MULES

Class	Range in height	Range in weight
	(Hands)	(Pounds)
t	16 to 17-2	1200-1600
r	16 to 17	1150-1300
n	15-2 to 16	900-1250
on	13-2 to 15-2	750-1100
and Mining	12 to 16	600-1350

Naturally, there is considerable spread in value between the als within each class—depending upon weight, conformation, ty, temperament, condition, action, age, and soundness. Mare

mules usually outsell horse mules. The most desirable age is between four and eight years, and well-matched spans of black or sorrel mules are most popular.

Draft Mules

Draft mules are the finest mules in type and quality, weighing from 1,200 to 1,600 pounds and standing 16 to 17-2 hands in height. The mules exhibited in the great livestock shows of the



Fig. 351. A draft mule. Height 16 hands ¼ inch, weight 1,600 pounds. Note the thickness and draftiness of this mule, and the excellent feet and legs. (Courtesy, Horse Association of America.)

country classify as draft mules. These animals are used primarily for heavy teaming and farming in the central and southern states. A limited number are still used on contract jobs—road work, railroads, and in lumber camps.

Sugar Mules

Sugar mules are the sugar plantation mules of the South. They are intermediate in size and have a weight somewhere

een that of draft and farm mules. Sugar mules weigh 1,150 ,300 pounds and are 16 to 17 hands tall. Mules of this class t show considerable quality and finish.

n Mules

Farm mules are those purchased for use on farms in the ral states. These mules are often more plain looking, thinner



Fig. 352. A farm mule. These mules are often more plain looking, thin- n flesh, and show less evidence of quality than draft mules. (Courtesy, se Association of America.)

esh, and show less evidence of quality than draft mules. The t desirable farm mules stand 15 to 16 hands in height and gh from 800 to 1,250 pounds.

ton Mules

As the name would indicate, mules of this type are used narily by cotton growers in the South to plant, cultivate, and vest the cotton crop. They weigh from 750 to 1,100 pounds stand from 13-2 to 15-2 hands high. Cotton mules are some- t lighter and more angular than sugar mules. They also sess less quality.



Fig. 353. A cotton mule. This is a smooth, well-finished type of excellent quality and with an unusually good set of legs and pasterns. (Courtesy, Horse Association of America.)



Fig. 354. A pack mule. This mule is a very deep chested, thick made animal, with powerful back and loin, and with excellent slope of pasterns. However, he is crooked on the [illegible] legs, being sickle hocked. (Courtesy, Horse Association of America.)

k and Mine Mules

Pack mules are used for transport work—carrying heavy s on their backs—in very rough or wooded country not acces- e to vehicles. The Forest Service uses some animals of this e. A limited number of mining mules are still used to haul of ore or coal to the hoisting shafts.

Both pack and mining mules are of similar size and type. y must be close to the ground, thick and blocky, and possess rong back and loin. They range in weight from 600 to 1,350 nds and in height from 12 to 16 hands. Horse mules are often ferred to mare mules for this class.



Fig. 355. Pack mules in use in rough country not accessible to motor icles. (Courtesy, Horse Association of America.)

CHAPTER XXXVII

BREEDS OF LIGHT HORSES

There is scarcely a breed of horse that does not possess one or more distinctive breed characteristics in which it excels all others. Moreover, any one of several breeds is often well adapted to the same use. To the amateur, this is most confusing, and he is prone to inquire as to "the best breed." Certainly, if any strong preference exists, it should be an important factor, though it is recognized that certain breeds are better adapted to specific purposes.

RELATIVE POPULARITY OF BREEDS OF LIGHT HORSES

Table 72 shows the 1949 and total registrations to date of the various breeds of light horses. At the present time, it appears that the Quarter Horse and Tennessee Walking Horse are increasing more rapidly than any other breeds of light horses.

TABLE 72

1949 AND TOTAL REGISTRATIONS OF LIGHT HORSES IN UNITED STATES BREED ASSOCIATIONS[1]

Breed	1949 registrations	Total registrations
Quarter Horse[3],[4]	10,412	24,292
Thoroughbred	8,500	----
American Saddle Horse	3,902	82,147
Standardbred[4]	3,247	200,741
Tennessee Walking Horse	2,510	35,877
Palomino[2]	1,482	13,198
Shetland Pony	920	27,153
Arabian	650	5,700
Morgan	480	18,238
Appaloosa	395	1,307
Pinto[4]	95	635
Welsh Pony	40	1,300
Hackney	----	----

[1] *New England Homestead*, Springfield, Mass., Sept. 23, 1950, Vol. [illegible] 40.

[2] Includes both breed associations (Texas and California.)

[3] Includes registrations in both the American and National Quarter Horse Associations.

[4] Figures for 1947.

E AMERICAN SADDLE HORSE

The American Saddle Horse is distinctly an American crea-
. With at least passable roads in the East, the breeding of
ness horses was centered in this area, particularly in the
nity of New York and Philadelphia. Farther inland, however,
ds were few and far between, and horses' backs afforded the
ef means of transportation. The early residents of Kentucky,
nessee, Virginia, and West Virginia selected animals with
y, lateral, ambling gaits, finding these to be most desirable
ride over plantations and hilly and rolling grazing areas,
ecially on long journeys.

gin and Native Home

The creation of the American Saddle Horse had its unplanned
inning with the settlement of the plantations of the states
ntioned above. Later, Missouri took up the breeding of easy-
ted saddle horses. These southern pioneers, who never rode
h short stirrups and who regarded posting as a heathenish
ention of the English, very early selected and imported amb-
g types of horses from Canada and the New England states.
nada at that time had a sturdy little horse which paced; it was
own as the Canadian pacer. Animals of the Thoroughbred
ed and what later proved to be the forerunners of the Morgan
d Standardbred breeds were also infused. The type of horse
manded was one that could travel long distances without dis-
ss to either the horse or the rider and which possessed beauty,
ed, tractability, intelligence, courage, durability, longevity,
d versatility (adaptable to harness use if desired). Conditions
ling for horses of this type prevailed throughout the states
ntioned, beginning with the earliest settlement. It is not sur-
ising, therefore, that the men, women, and children of this area
became equestrians.

The amalgamation of diverse blood continued and with it
nstant selection for the desired qualities, particularly adapta-
lity to easy riding gaits. Eventually, the plantation owners
ed a definite and beautiful type, even though it was not to be
own as a breed until many years later, no breed registry
sociation being formed until 1891.

The modern American Saddle Horse now traces most of its
igin to a four-mile Thoroughbred race stallion, Denmark
oaled in 1839). Although this horse did not achieve great fame
the track, his races were said to be characterized by unusual

stamina and gameness. Denmark left numerous progeny, but his most notable offspring was Gaine's Denmark, out of a natural ambler of native stock, known as the Stevenson Mare. Many have credited this mare with being of greater foundation importance than Denmark himself. Certainly the Stevenson mare supplied the genetic basis for the gaits so easily attained by her descendants. To Denmark, however, credit must be given for the courage, breediness, shoulders, fineness of head and neck, clean dense bone, and quality of the sons and daughters of many subsequent generations. In considering the diverse breeding of the native stock from which the breed sprung, including the Stevenson mare —without in any way minimizing the influence of the Thoroughbred—one might even conclude that the American Saddle Horse is indebted to the Canadian Pacer for his easy riding gaits; to the Morgan for his docility, beauty, and animation; and to the Standardbred for a good trot.

In 1901, the American Saddle Horse Breeders' Association approved a list of ten stallions as entitled to rank as the great



Fig. 356. Captain Courageous, one of the leading sires of the American Saddle Horse breed, owned by Winganeek Farm, Lexington, Kentucky. Note the beautiful head carried on a long graceful neck, the short back, well-turned croup, high-set tail, and stylish appearance. (Courtesy, American Saddle Horse Breeders Association.)

ndation sires of the breed. There can be little question, how-
r, that Denmark, largely through his illustrious son, Gaine's
nmark, was greatest of all.

erican Saddle Horse Characteristics

The chief distinguishing characteristic of horses of this
ed is their ability to furnish an easy ride with great style and
mation. Park hacks may be either three- or five-gaited, the
ice being largely a matter of preference and training. Walk-
t-canter horses are known as three-gaited; whereas animals
sessing the rack and in addition, a "slow gait" (running walk,
trot, or slow pace) are known as five-gaited.

Members of the breed are usually bay, brown, chestnut, gray,
black in color. Flashy white markings are frowned upon. Most
them stand from 15 to 16 hands in height and weigh from
00 to 1,200 pounds.

The American Saddle Horse is noted for a beautiful head
ried on a long graceful neck, short rounded back, well-turned
up, high-set tail, and proud action. The entire ensemble is
hout a peer when it comes to style, spirit, and animation. At
same time, members of the breed are docile, intelligent, and
ctable.

aptation and Use

The American Saddle Horse is now used almost exclusively
a three- or five-gaited saddle horse. Many of these horses are
ll used for business purposes, but by far the greater number
the top animals are used as pleasure horses—either on the
dle paths or in the show ring.

Many of the best fine harness show horses come from the
nerican Saddle Horse, and it has been said that horses of this
eed meet the demand for combination horses better than any
ner group. Animals of American Saddle Horse extraction are
asionally used as stock horses, jumpers, cavalry mounts, and
other light horse purposes; but their versatility does not
proach that of the Thoroughbred. They are primarily a park
ck, for which use they are pre-eminent.

esent Status of the Breed

Well-trained American Saddle Horses of good type have
joyed a broad demand at good prices for many years. This
mand has come mostly from city people who use the saddle
rse for purposes of pleasure, recreation, and exercise. Although

representatives of the breed are found in every state, Kentucky and Missouri continue as the great breeding centers.

THE APPALOOSA

The Appaloosa is of particular interest in northwestern United States because it played a major role in the Indian Wars and in the development of the early-day livestock industry.

Origin and Native Home

Ancient art attests to the fact that spotted horses are as old as recorded history. Without doubt, the ancestors of the Appaloosa were introduced into Mexico by the early Spanish explorers. Eventually, (about 1730) through trading, wars, and capturing strays, the Nez Perce tribe of American Indians came into possession of some of these spotted horses. The Indians were pleased with these colorful mounts and greatly increased their numbers on their fertile ranges in northeastern Oregon, southeastern Washington, and the bordering area in Idaho. Eventually, these horses came to be known as the Appaloosa, which name is said to be derived from the word Palouse, which in turn came from the French word "peluse," meaning grassy sward. The rolling Palouse country was formerly covered by virgin prairie, but it is now a world famous wheat and pea country.

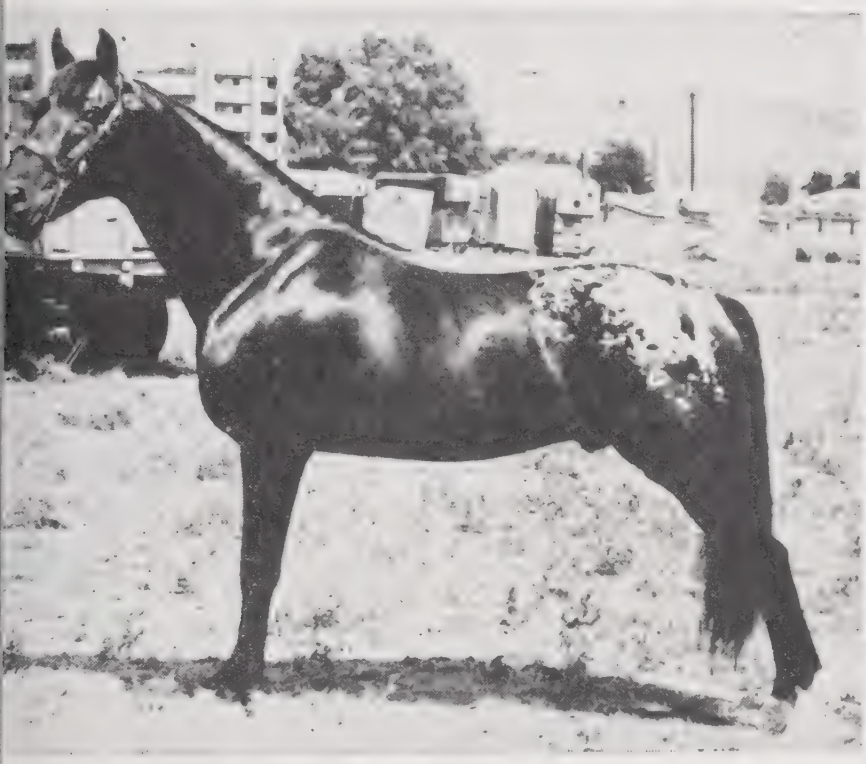
For many years most of the Appaloosa horses were owned by the Nez Perce tribe, but the War of 1877 resulted in their being scattered throughout the West. Finally, on December 30, 1938, the Appaloosa Horse Club was organized for the purpose of preserving and promoting the breed.

Appaloosa Characteristics

Appaloosas may show many variations and combinations of unusual coat patterns, but the colorful spots are characteristic. Most members of the breed are white over the loin and hips, with dark, round, or egg-shaped spots varying in size from specks up to three or four inches in diameter. The eye is encircled by white, the same as the human eye; the skin is mottled; and the hoofs are striped vertically black and white.

Adaptation and Use

Though once used for war, racing, and buffalo hunting, the Appaloosa is now used as a stock horse or pleasure and parade mount.



ig. 357. Medicine Man, Grand Champion Stallion of the 1949 National oosa Horse Show, Lewiston, Idaho. Medicine Man is owned by Wallace ields, San Jose, California. Note the flashy spots over the loin and ; a characteristic of the breed. (Courtesy, Wallace E. Shields.)

ent Status of the Breed

Today the Appaloosa is rare, only a few hundred horses registered in the Appaloosa Horse Club. Effective August 49, to be eligible for registry, an animal must be out of tered Appaloosa parents or must have one registered Appa- parent. The other parent must be a registered Arabian.

ARABIAN

Many writers have credited the Arabs with having first sticated the horse, but this is not the case. The preponder- of evidence favors the belief that the foundation stock of Arabian horse was obtained many centuries following their stication from either the Egyptians or the Libyan tribes rthern Africa.

in and Native Home

The Arabian, oldest breed of horses and the fountainhead l the other light horse breeds, was developed in the desert

country of Arabia, from which it derives its name. Regardless of the clouded obscurity that surrounds the early origin of the breed, it is generally recognized that, through long and careful mating, the Arabs produced a superior type of horse which would carry them swiftly and safely over long stretches of sandy soil and at the same time withstand deprivations in feed and water to a remarkable degree. As the Bedouins of the desert were a warring, pilfering tribe, the very safety of their lives often depended upon a swift escape. Such was the need, and out of this need was developed the Arabian horse. Legend has it that the Arabs at night would often steal semen from a highly prized stallion owned by an enemy tribe and inseminate their mares therefrom. This was the first artificial insemination of farm animals.

It is easy to understand how the environmental conditions surrounding the development of the Arabian breed could and did give rise to myth and exaggerated statements as to the speed, endurance, docility, and beauty of the breed. At one moment, the Arab was cruel to his mount; then again he would shower him with kindness. During the latter moments, he was wont to remark, "Go and wash the feet of your mare and drink the water thereof."

Early American Importations

The Arabian stallion, Ranger, was imported into Connecticut in 1765. Ranger was the sire of the gray charger ridden by General Washington in the Revolutionary War. Throughout the nineteenth century many other notable importations followed, all of which gave a good account of the breed and encouraged other purchases.

Arabian Characteristics

The distinctive characteristics of the Arabian breed are medium to small in size, a beautiful head, short coupling, docility and great endurance. The usual height is from 14 to 15-1 hands and the weight from 850 to 1,100 pounds. A typical Arabian has a beautiful head, broad at the forehead and tapering toward the nose; a dished face; short alert ears; large clear eyes that are set wide apart; large nostrils; and deep, wide jaws. The Arabian also possesses an anatomical difference in comparison with other breeds, having one less lumbar (back) vertebra and one or two fewer vertebrae in the tail. In conformation, the Arabian breed is further noted for proud carriage of the head on a long and

ful neck; well-sloped shoulders and pasterns; a short back
oin; well-sprung ribs, a high well-set tail; deep quarters;
uperior quality of underpinning without any tendency to
r leggy.

The predominating colors are bay, gray, and chestnut, with
casional white or black. According to an old Arab proverb,
fleetest of horses is the chestnut; the most enduring the
the most spirited the black, and most blessed the white."



ig. 358. Muallim, Arabian stallion owned by the State College of
ington. Note his beautiful head, neck, and shoulders; qualities charac-
cs of the breed. (Courtesy, The State College of Washington.)

e marks on the head and legs are common, but purebred
ians are never piebald, skewbald, or spotted—circus and
e information to the contrary. The skin is always black, no
er what the coat color.

The better horses in Arabia, consisting of a relatively small
oer of animals owned by the tribes in the interior desert,
always been bred and raised in close contact with the fami-

lies of their masters and are renowned for affection, gentleness and tractability.

Adaptation and Use

The Arabian horse was primarily developed as a saddle horse, a use which still predominates among the breed today. Generally animals of this breed are trained and used at the three gaits: the walk, trot, and canter. Occasionally, however, purebred Arabians are trained to execute five gaits to perfection. Animals of this breed are easily broken to make a safe, although not a fast, driver in light harness.

The Arabian has made an invaluable contribution in the development of most all breeds, adding to their courage, endurance, quality, intelligence, docility, and beauty. It is no exaggeration to say that the prepotent blood of the Arabian has refined and improved all those breeds with which it has been infused.

Present Status of the Breed

At the present time, no great number of high-class Arabians remain in the country of their origin. In addition, World Wars I and II have devastated most of the better breeding establishments of Europe. Thus the future preservation of the breed would appear to rest primarily with American breeders.

THE HACKNEY

The Hackney is the most prominent of the five breeds of heavy harness or carriage horses. In fact, except for the Hackney, the other breeds of this type are now practically extinct in the United States and are of historic interest only.

Origin and Native Home

The very name Hackney, and its abbreviated derivative "Hack," is suggestive of the type and adaptation of this breed, denoting both a general purpose horse and the vehicle which he draws.

The breed originated in Norfolk and adjoining counties on the eastern coast of England. Here, in the first half of the eighteenth century was developed a fast-distance, trotting-type horse known as the Norfolk trotter, the native stock with Thoroughbred infusion from which the Hackney was later derived. In this period, roads and vehicles were few and primitive, so that these Norfolk trotters were used chiefly under the saddle. Well authenticated records exist of travel at the rate of seventeen miles per hour over ordinary roads.

The real beginning of the Hackney breed is traced to a on known as Blaze,[1] a Thoroughbred foaled in 1733 and a dson of the immortal Darley Arabian, the latter being the noted of the foundation sires of the Thoroughbred breed. and his noted son, Old Shales (foaled in 1755), produced a rkably valuable riding and driving horse when crossed on ative stock of Norfolk.

The early formative period of the Hackney was before the nt of either the carriage or the railroad. Thus, these sturdy dation animals were first used under the saddle and were employed for some light agricultural purpose. It was not mmon in that era to see a farmer riding to market with his se behind him on a pillion.[2] Such use called for attractive als with adequate size and substance and the ability to trot distances at a fair speed.

With the development and use of the British hackney coaches e eighteenth century, the Hackney became specialized for ng purposes. It soon became the leading heavy harness horse e world, which position it still retains. With this specialized nd its increased popularity with the aristocracy of England, Hackney's naturally high, trappy action was cultivated. As of the vehicles were heavy, animals with size and a robust ormation were demanded. With it all, graceful, curved form, ty, and style were emphasized. In brief, the quality and per- ance of the heavy harness horse became an indication of l prestige.

y American Importations

One of the earliest, if not the first, Hackney to be brought merica was a stallion named Pretender, a great grandson of Shales, imported to Virginia in 1801. Subsequent importa- followed, but it was not until the era of the Gay Nineties any great numbers were brought over. At this time, a boom Hackneys developed in this country as prancing carriage es became characteristic of the avenues traversed by the thy in the eastern cities.

[1] The same Blaze from whom imported Messenger, the foundation sire e Standardbred was descended. Thus, on the sire's side the Hackney Standardbred were of similar origin, but the native mares which served undation stock for the respective breeds and the objectives sought were different.

[2] A seat or cushion which was put behind the gentleman's saddle.

Hackney Characteristics

Chestnut, bay, and brown are the most common colors found in the Hackney breed, although roans and blacks are seen. Regular white marks are rather common and are even desired for purposes of accentuating high action. In the show ring, custom decrees that heavy harness horses be docked and have their manes pulled.



Fig. 359. Killearn Beauty, Champion Hackney mare, owned by Argyl Stables of Mount Carroll, Illinois, and driven by Mrs. Mary K. Holt. Note the characteristic Hackney style, high action, and smooth, gracefully-curved form. (Courtesy, The National Horseman, Louisville, Kentucky.)

In size, the Hackney varies more than any other breed of horses, ranging from 12 to 16 hands. The small Hackney pony, under 14-2 hands in height, and the larger animals are registered in the same stud book. When used in a pair for a lady's phaeton, smaller animals are preferred. Because of the weight of the vehicle, however, a larger animal is necessary when driven single. As would be expected with the wide range in height of the breed, Hackneys vary considerably in weight, from 800 to 1,200 pounds.

Typical Hackneys are relatively short-legged horses, rather robust in conformation; heavy in proportion to their height; smooth and gracefully curved in form, with symmetry and balance; and upheaded, clean-cut, alert, and stylish to a high degree.

natural action—which is accentuated by skilled training, ng, and shoeing—is perhaps their most distinguishing re.

tation and Use

The Hackney is the heavy harness horse *par excellence* for the show ring and park driving. Many hunters and jumpers half-bred Hackneys, and they get their desired size from breed.

Today, the Hackney is essentially a show animal, noted for b quality, beautiful condition, and spirited high action. drawing a proper vehicle devoid of shiny parts (which to blind the spectators), the well-trained Hackney is a erful spectacle to behold.

ent Status of the Breed

The nearer the street surfaces approach perfection for auto- le traffic, the less satisfactory they are for use by horses. , at the present time, the use of the Hackney is almost sively confined to the show ring. On the tanbark, these high- ing horses are still the show, and, to many, their appearance miniscent of the Gay Nineties.

MORGAN

The Morgan has been known as the "first family of American es." The early development of the breed took place in the England states, thus giving the eastern section of the coun- primary credit for founding three light-horse breeds.

in and Native Home

The origin of the Morgan breed was a mere "happenstance" not the result of planned effort on the part of breeders to uce a particular breed of horse which would be adapted to conditions. Whatever may be said of the greatness of Justin gan, he was the result of a chance mating—one of nature's ets for which there is no breeding formula. In fact, it may aid that had a British general downed his liquor in his own or and had a Springfield, Massachusetts, farmer been able to his debts, the first family of American horses might never existed. Legend has it that one evening during the Revolu- ary War Colonel De Lancey, commander of a Tory mounted ment, rode up to an inn at King's Bridge and after hitching family stallion, True Briton, to the rail, went into the inn

for some liquid refreshments, as was his custom. While the Colonel was celebrating with liquor and song, the Yankees stole his horse, later selling the animal to a farmer near Hartford, Connecticut. The whimsical story goes on to say that True Briton later sired the fuzzy-haired colt that was to be christened after his second owner, Justin Morgan.

According to the best authorities, Mr. Morgan, who first lived for many years near Springfield, Massachusetts, moved his family to Randolph, Vermont, in 1788. A few years later, he returned to Springfield to collect a debt. But instead of getting the money, he bartered for a three-year-old gelding and a two-year-old colt of Thoroughbred and Arabian extraction. The stud colt, later named after the new owner, as was often the custom of the day, became the notorious horse, Justin Morgan, the progenitor of the first famous breed of horses developed in America.

Justin Morgan was a dark bay with black legs, mane, and tail. His high head was shapely cut; his dark eyes were prominent, lively, and pleasant; his wide-set ears were small, pointed, and erect; his round body was short-backed, close-ribbed, and deep; his thin legs were set wide and straight, and the pasterns and shoulders were sloping; his action was straight, bold, and vigorous; and his style was proud, nervous, and imposing. Justin Morgan was a beautifully symmetrical, stylish, vibrant animal—renowned for looks, manners, and substance. It was claimed of him that he could outrun for short distances any horse that he was matched against. He was a fast trotter, a great horse on parade under saddle, and he could outpull most horses weighing several hundred pounds more.

Justin Morgan lived his thirty-two years (1789-1821) in an era of horses rather than in an era of power machinery. The westward expansion had been limited; roads and trails were in the raw, as nature had left them, and were often impassible even with a horse and buggy. Virgin forest had to be cleared, and the tough sod of the prairie had to be broken. These conditions called for an extremely versatile type of horse—one that could pull a good load on the farm, could be driven as a roadster, could be raced under the saddle, and could be ridden in a parade. Justin Morgan and his progeny filled this utility need in a most remarkable manner. In due time, in 1893 to be exact, many years following the death of the foundation sire and after a decade of exhaustive research, Colonel Joseph Battell published Volume 1 of the American Morgan Horse Register. Such was the beginning of

ervation of the lineage of the breed—a registry assignment handled under the same name by the Morgan Horse Club.

gan Characteristics

With shifts in use, it is but natural to find considerable ation in the size of present-day Morgans. Yet throughout the situdes of time and shifts in emphasis that have occurred ng the past hundred years, Morgan horses to an amazing ee have continued to have certain unique characteristics h distinguish them as a breed.

The height of representative animals ranges from 14-2 to 16 ls, with the larger animals now given preference by most emen. The average Morgan weighs from 800 to 1,200 pounds. dard colors are bay, brown, black, and chestnut; and white kings are not uncommon.



Fig. 360. Abbott, Morgan stallion, bred by the U. S. Department of iculture. In comparison with early-day Morgans, Abbott is larger, more anding, longer necked, and possesses more slope to the shoulders and terns. This change in type has come about as a result of a shift in the of the breed—a shift from use as a utility horse to use as a riding se. (Courtesy, Morgan Horse Club.)

In conformation, the breed has retained most of the characteristics attributed to the foundation sire. With greater emphasis on use under the saddle, however, modern Morgans are inclined to be more upstanding, to have longer necks, and to possess more slope to their shoulders and pasterns. Regardless of type changes, the breed continues to be noted for stamina, docility, beauty, courage, and longevity. The presence of only five lumbar vertebrae in many Morgans is attributed to the use of Arabian breeding.

Adaptation and Use

In the early formative period of the breed, the Morgan was thought of as a general purpose type of animal—for use in harness racing, as roadsters, on the farm, on the avenue, in the park, on the range, and on the trail. With the development of mechanization, many of these needs passed into oblivion. The more progressive breeders, fully cognizant of the change in needs, took stock of the breed's inherent possibilities and shifted their efforts in breeding and selection to the production of a superior riding horse. At the present time, therefore, it is not surprising to find that there is considerable variation in emphasis in different sections of the United States. In the West, the Morgan is primarily a stock horse in the central states it is still a general purpose breed; whereas in the East the emphasis is upon the Morgan as a saddle horse, particularly for general country use and for recreational purposes over the hundreds of miles of trails.

The comparatively small number of purebred Morgans today is no criterion of the true importance of the breed. Their influence has literally extended to the entire horse population of the continent. Morgan blood was used in laying the foundation for many breeds. The leading Standardbred families of today are a fusion of Hambletonian lines with the Morgan—Axworthy, Mako, and Peter the Great all carried Morgan blood in their veins. Likewise, the American Saddle Horse is indebted to the Morgan, for the Peavine and Chief families both contained Morgan ancestry. Allen, the foundation sire of the Tennessee Walking Horse, was a great grandson of a Morgan, Vermont Black Hawk.

Present Status of the Breed

During the period of transition and shift in emphasis from a utility and harness type of horse to use under the saddle, the registration of Morgan horses declined, and the identity of many registered animals was lost. This greatly reduced the number of

able breeding animals to use as a base for the rapid expan- of breeding interest that has occurred during the past le. The Morgan Horse Club indicates that "The annual rate gistration during this period has more than quadrupled, and ate of increasing is being well sustained."

In 1907 Colonel Battell—an admirer, breeder, and founder e Register of Morgan Horses—presented to the U. S. Depart- of Agriculture what became known as the United States gan Horse Farm, near Middlebury, Vermont. Colonel Battell's ary objective in presenting the farm to the Federal Govern- was that of providing a place upon which the breed could erpetuated and improved. Though it would appear ironical y, it was also rumored that the old gentleman was disturbed the high taxes of the period and had decided that the only to "beat the Government" was to give his holdings to the ed States. Regardless of the possible latter objective, it must greed that the U. S. Morgan Horse Farm was a powerful ence in perpetuating and improving the Morgan breed. Effect- uly 1, 1951, by authorization of the U. S. Congress, the United es Morgan Horse Farm was transferred without cost to the mont Agricultural College.

PALOMINO

The word "palomino" correctly implies a horse of a golden with white, silver, or ivory mane and tail, rather than a d. In the secretary's report that appears in Volume V of the Book and Registry, October, 1946, this fact is made clear in following statement: "Contrary to public opinion, palominos ctively are neither a breed nor a type. At present they are ly a color." It is the announced objective of the Association erpetuate the palomino color in all light horses, regardless of .

gin and Native Home

When, in the course of the Mexican War—which ended in 8, over one hundred years ago—the United States acquired t is now the state of California, many attractive golden- red horses of good type were found in the new territory. According to the best records available, these animals were introduced from Spain to the New World beginning with tez, in 1519, and their introduction was continued by other nish explorers. Evidently these horses had long been bred color in Spain, being used exclusively as the distinctive

mounts of the Royal Family, the nobility, and high military officials. In Spain these golden-colored animals were known as "The Horse of the Queen," and their use by commoners was forbidden. It is also known that the Spaniards obtained the golden horse from Arabia and Morocco, but further than this their origin is clouded in obscurity.

In the early days of California, palominos were extremely popular. Spanish gentlemen took pride in ownership of these beautiful mounts, which were also used as the race horses in early California. However, with the importation of the Thoroughbred and other horses of light-horse extraction from the eastern seaboard and Europe, the golden horse was threatened with extinction. Only in recent years has his popularity again come to the fore, finally resulting in the formation of the breed registry. At the present time an animal may be accepted in the Palomino breed registry according to divisions, provided that: (1) Its sire or dam (either or both) is registered in the Palomino Horse Breeders Association of America, or (2) the animal itself or its sire or dam (either or both) is a registered American Saddle Horse, Quarter Horse, Arabian, Morgan, Thoroughbred, or Tennessee Walking Horse. The Thoroughbred and Arabian registries prohibit double entry; that is, registrations in their respective associations and also in the Palomino association; but the other four associations contain many Palominos which are also registered in the Palomino Association.

In Volume V of the Stud Book and Registry, the secretary reports that on June 1, 1946, the registration according to breed divisions stood as follows:

American Saddle Horses	159
Quarter Horses	125
Tennessee Walking Horses	115
Thoroughbreds	86
Arabians	74
Morgans	32

It is also reported that of the 5,157 horses registered in the association only 673 were foaled from matings of Palomino to Palomino—the remaining 4,884 being foaled from matings of Palomino to other colored horses.

Palomino Characteristics

The Palomino must be golden in color (the color of a newly minted gold coin or three shades lighter or darker), with a light colored mane and tail (white, silver, or ivory, with not more

5 per cent dark or chestnut hair in either). White mark-
n the face or below the knees are acceptable. The skin and
hall be dark. The usual height range is from 15-2 to 16
and the weight from 1,000 to 1,200 pounds.
s might be expected, in an attempt to form a new breed
a color requirement as first and foremost, considerable
ion in type exists. However, the association does prohibit



g. 361. Chappie II, Champion Pleasure-type Palomino Stallion of the
exas State Fair, Dallas. Owned by J. T. Boothman, Ft. Worth, Texas.
ost distinguishing characteristic of the Palomino is the golden color,
a light-colored mane and tail. (Courtesy, Palomino Horse Breeders
erica.)

egistration of animals of draft-horse or pony breeding and of
ffspring of piebald or true albino animals. Other than this, it
d be emphasized that the Palomino as such is neither a
nor a type, for there are Palomino colored horses of various
and breeds. The Palmino Assocation has as its stated
ary objective the perpetuation of the Palomino color—not
y particular type of horse but on horses in general. In ad-
to color, emphasis is placed on good dispositions and well

executed gaits at the walk, trot, and canter. In addition, some animals also perform at the rack and a slow gait.

Genetic studies of the Palomino indicate that the color is unfixable; that it cannot be made true breeding, no matter how long nor how persistent the effort. Further, there appears to be ample theory—substantiated by practical observation—to indicate that Palomino foals may be produced by any one of the following four types of matings: (1) Palomino x Palomino, resulting in the production of foals in the ratio of 1 chestnut: 2 Palomino: 1 albino;[1] (2) Palomino x chestnut, producing foals in the ratio of 1 chestnut: 1 Palomino; (3) Palomino x albino, producing foals in the ratio of 1 Palomino: 1 ablino; (4) Chestnut x albino, producing only Palomino foals.

As indicated, when Palomino mares are bred to a Palomino stallion, the colts are, on the average, of the following colors: one-half of them Palominos, one-fourth of them chestnut, and one-fourth of them so-called albinos. Also it is noteworthy that chestnut x albino matings produce only Palomino foals.

Adaptation and Use

In its constitution and by-laws, the Palomino Horse Breeders of America, Inc., recommends the following divisions for horse-show purposes: "(a) stock horse, (b) parade, (c) bridle path or pleasure horse, (d) gaited or fine harness, and (e) Tennessee Walking Horse." Perhaps this classification within itself constitutes the best summary of the diverse adaptations and uses now being made of Palominos.

Present Status of the Breed

As of January, 1947, a total of 5,600 animals had been registered. It is to the credit of the Association and the breed enthusiasts that they have done a wonderful job in selling the public on the beauty of the Palomino. They have accepted Palomino colors from among six of the light-horse breeds and have wisely admonished the breeders themselves to improve the type.

THE PINTO HORSE

The word "pinto" refers to a marked or spotted horse. A description first applied to the spotted descendants of the horses of the Spanish conquerors. Sometimes, though less correctly, animals of this color are referred to as piebald, skewbald, paint, and calico.

[1] The term "albino" as herein used is familiar to horsemen, but it does not refer to a true albino as exists in white mice, rats, and rabbits.

and Native Home

potted or Pinto horses first arrived in the New World with panish Conquistadores. From that day forward, animals s color played a leading role in the development of the Many of them were captured and used as the highly prized horses of the American Indians. Later they were found g the feral horses of the West; and most important, gh the years, many of them have been used as stock horses.

Characteristics

he most distinctive characteristics of the Pinto horse is his The perfectly marked representative is half color or colors lf white, with many spots well placed. The spots may range e from two to twelve inches across, and they may or may e uniform in placement, size, and regularity of shape. Thus, Horses are renowned for their vari-colors, appearance, , and captivation.

he height ranges from 13-2 to 16-2 hands, and the weight 750 to 1,300 pounds. In conformation, the best representa- of the breed are comparable to the type of any well-bred e horse of any breed. The glass eye is a part of the Pinto e and is not to be discounted.

tation and Use

olonel F. W. Koester has well summarized the adaptation se of the Pinto horse in the following statement:[1] "There Pinto pony—long the pride and joy of millions of American . We find Pintos, too, among cow ponies and polo ponies, ers, hunters and other sporting types. Again, among the ure types such as trail horses, hacks, and particularly parade s, the Pinto enjoys wide and deserved popularity." In brief, into is adapted for use for any light-horse purpose but is ially superb as a show, parade, novice, and pleasure animal.

nt Status of the Breed

he Pinto is primarily of two types: (1) Western Saddle es and (2) American Parade type. The breed enthusiasts

[1] There are three distinct pattern markings of the Pinto: (1) The Ap- a—a colored horse with a white croup in which there are spots and e other white markings; (2) Overo—a colored horse with white areas ding upward from the belly and lower regions, possibly other white ngs, and (3) Tobiana—in which white areas of the dorsal region ex- downward and which may have other white markings as well.
Colonel F. W. Koester, "The Pinto's Place Now and in the Future," *al Stud Book and Registry, The Pinto Horse Society*," Vol. 4, Decem- 1, 1945, pp. 13 and 14.

have never attempted to dominate other breeds nor to make wild claims for their representatives. Rather, they are wisely attempting to preserve, improve, and extend the use of a type and color of horse whose development has gone hand in hand with the transformation of America itself.

THE QUARTER HORSE

The earliest form of horse racing in America—particularly in Maryland, Virginia, and the Carolinas—was through necessity usually over a quarter-mile track. The topography and the wilderness were such as to make difficult the construction of formal race tracks. Rather, small "race paths" were literally hewn out of the wilderness. Many of these courses were down the main street of the town, as this was the only straight and cleared stretch available. To race over these tracks, the pioneers selected sturdy stock possessed of a great burst of speed at short distances.

Origin and Native Home

Although the breed registry association did not come into existence until 1940, the Quarter Horse had its beginning some three hundred years ago with the crude quarter-mile "race paths" of pioneer days. Those heavily muscled, sturdy animals, best adapted to these rugged courses in matched races, were to serve as the foundation stock of a now popular western breed. With the advent of the Thoroughbred and the construction of formal race tracks of greater length in the East, Quarter Horse racing stock was pushed to the West and Southwest. In the range states these rugged animals continued to flourish for "quarter racing," and they endeared themselves as the ideal "cow pony."

There are two schools of thought relative to the ancestry of the Quarter Horse: (1) that the foundation stock consisted of the native mares of Spanish extraction in Virginia, Maryland, and the Carolinas which were mated to Thoroughbred stallions, and (2) that little or no Thoroughbred blood was infused, for—so it is argued—the foundation of the Quarter Horse was laid a hundred years before the first Thoroughbred horse was imported to America in 1730.

It is known that the early improvement of the Quarter Horse and the Thoroughbred were closely associated. Perhaps the truth of the matter is that certain animals contributed notably to each breed.

Most authorities recognize as the Quarter Horse patriarch mported Thoroughbred stallion Janus (1756-1780), a tested mile racer in England. It is reported that Janus' progeny unexcelled for a great burst of speed over short distances, ike their sire, they were sturdy in build and possessed pow- muscling in the hind quarters.

Since there was no Quarter Horse registry prior to 1940, incredible that the purity of the breed could have been tained through more than three hundred years of an un- ed beginning. Suffice it to say that the distinctive breed evolved at the end of this period is ample evidence of the cy of the foundation stock, and of the superior quality of lood infused through the years—regardless of its source.

Steel Dust, the most famous of all Quarter Horses, made his in Texas around the middle of the nineteenth century. his fame became known, it was said that he nearly bank- d a certain Texas community in which he first appeared in tched race with a notorious racer of the day. In commenting e influence of Steel Dust in molding the breed, Robert Den- states that "Every horse trader who has not recently joined rch will modestly admit that his horses are direct descend- of Steel Dust." There are some eleven prominent families in the Stud Book and Registry, most of which either nated in or were introduced in Texas.

ter Horse Characteristics

The Quarter Horse is somewhat "chunky" in build, seldom eding 15 hands in height and they generally weigh from to 1,200 pounds. The head, which is somewhat short, is ict because of the small alert ear and heavily muscled cheeks owl. The neck is well developed, the back and loin short and ly muscled, the forearms and rear quarters are powerfully led, and the legs relatively short. The entire ensemble is as to make him an ideal stock horse—an animal that is and speedy, capable of outrunning any "critter." He pos- s sufficient weight and power to hold a heavy steer when l and has a calm disposition even in the roundup.

At the present time, most Quarter Horse breeders and es are selecting away from the extreme "bulldog type" that so popular a few years ago. Although desiring to retain a

The Quarter Horse—A History, The American Quarter Horse Associa- Stud Book and Registry, Vol. I, 1941, p. 18.

well-muscled and powerfully built horse, it is argued that a more moderately stocky type is more useful. With proper selection and adequate time, the desired transformation can be achieved.

The most predominating colors of the breed are chestnut, sorrel, bays and duns. Palominos, blacks, browns, roans, and copper-colored animals, however, are not uncommon. Pintos, appaloosas, and albinos are the only colors that are ineligible for registration.



Fig. 362. Geronimo, Quarter Horse Stallion sold by J. Ralph Bell, Canoga Park, California, to A. R. Levis, Henderson, Colorado, for $20,000. Note the "chunky," powerfully muscled conformation of this horse; characteristic of the breed. (Courtesy, The American Quarter Horse Association.)

Adaptation and Use

Quarter Horses are adapted and used chiefly for two purposes: (1) for quarter-mile racing, and (2) for cow ponies. Thus it follows that there are two schools of thought as to the best method of testing the performance of Quarter Horses: (1) to race them up to distances of a quarter-mile, and (2) to work cattle with them. Advocates of the first method are interested

arily in speed and racing, whereas advocates of the second iod are interested chiefly in a superior cow pony. Perhaps e combination of the two criteria is most desirable.

ent Status of the Breed

Despite the decline in the horse and mule population during past three decades, even the most pessimistic will agree that stock horse will always remain on the western range. Even Army's versatile little jeep does not threaten to take over the of roping a steer. Thus the future of the Quarter Horse breed as assured.

SHETLAND PONY

The Shetland Pony is the smallest of all horses. In addition s diminutive size, it is noted for its hardiness and good osition.



Fig. 363. Herd of Shetland Ponies. Note the sturdiness of these "miniature draft horses." (Courtesy, Horse Association of America.)

gin and Native Home

The Shetland Pony is native to the Shetland Isles, which lie hundred miles north of Scotland, parallel with central Norway not more than four hundred miles from the Arctic Circle. oric records give evidence that the breed was located in this ged area as early as the sixth century, A. D. This qualifies breed as one of the oldest in existence. Centuries of survival he rigors of the northland climate and on sparse vegetation endowed the breed with that hardiness for which it is justly ed.

Early American Importations

The first importations of Shetlands to the United States took place about the middle of the nineteenth century. Large numbers of subsequent importations followed.

Shetland Pony Characteristics

There are two distinct types of Shetlands, one of which is a "pocket-sized" draft horse and the other a "small edition" of a road-type horse. The latter, which evolved in this country through selective breeding, is often referred to as the "American type."

The true Shetland is less than 11-2 hands in height, and most individuals are less than 10-2 hands. Colors run almost the whole gamut of horse colors, with both broken and solid colors existing. Spotted ponies are more likely to have "glass" eyes, which are not to be desired.

By heritage, the Shetland pony is gentle and faithful, as it was developed about the house and with children and dogs in its native Shetland Islands.

Adaptation and Use

The Shetland pony is used almost exclusively as a children's pet and mount, being of small size and pre-eminent in gentleness. In years past, many of these sturdy little animals have been used by the coal mine operators of the British Isles for pulling coal cars in the underground mines. In their native land, their chief utility value consists of packing 120- to 140-pound loads of peat.

A harness-show type for use in the American show ring has been developed by crossing Welsh or Hackneys on Shetlands. These crossbreds, which may be registered as such, are active, stylish, and showy—beautiful to behold on the tanbark.

Present Status of the Breed

Wherever there are children, Shetland ponies will continue to be in demand. Although their numbers, probably will never approach that of the other light-horse breeds, it is likely that more and more Shetlands will come to provide healthful outdoor recreation for the boys and girls of America.

THE STANDARDBRED

Both the Standardbred and the American Saddle Horse are the result of a Thoroughbred top cross on native mares; both are truly American creations—the former developing as a road horse in the East and the latter as a saddle horse of the southern plan-

ns. In each case, the descendants of one Thoroughbred idual dominated the breed. Messenger, imported in 1788, ly shaped the Standardbred through his great grandson, bletonian 10; whereas, Denmark, foaled in 1839, largely mined the destiny of the American Saddle Horse through lustrious son, Gaine's Denmark. Despite these similarities ackground, two very different breeds evolved because of: he differences in the native mares used, and (2) selection as enced by the respective ends in view. In the case of the dardbred, the native foundation mares were trotters or rs adapted to fast driving in harness; whereas the native s used in molding the American Saddle Horse were amblers, to ride.

n and Native Home

e Standardbred, originally developed for road driving and g, descended from five sources: (1) the Thoroughbred, he Norfolk Trotter or Hackney, (3) the Arabian and Barb, he Morgan, and (5) certain pacers of mixed breeding. Origi- this breed was often referred to as the American Trotter, his designation is now discarded because the breed embraces trotters and pacers, all of which are registered in the same ciation. The name Standardbred is derived from the fact beginning in 1789, eligibility for registration was based on bility of the animal to trot the mile at 2:30 or pace the same nce at 2:25. Today, a record of performance is no longer a equisite to registration; it is merely necessary that animals ne offspring of recorded sires and dams.

The great pillar of the Standardbred was Rysdyk's Hamble- an or Hambletonian 10 (the latter designating his Standard ber in Vol. IV of the Register). This great stallion, foaled in , carried the blood of Messenger, a gray Thoroughbred stal- imported from England to Philadelphia in 1788 at the age ght, and imported Bellfounder, a Norfolk Trotter or Hack- foaled in England in 1815 and imported to Boston in 1822. breed can boast of a greater sire than Hambletonian 10. Dur- his 21 years in the stud, he sired 1,321 foals, and so famous ne become by virtue of the speed of his get that his service was placed at $500.

ndardbred Characteristics

In general, animals of this breed are smaller, less leggy and ess less quality than the Thoroughbred, but they show more

substance and ruggedness. The head, ears, and bone show less refinement, and the hind legs are not quite so straight as in the Thoroughbred. Standardbred animals attain speed through ability to extend themselves into long strides, repeated rapidly, because of the long forearm and long, narrow muscles.

In weight the Standardbred ranges from 900 to 1,300 pounds, and in height from 15 to 16 hands, with the average being around 15-2 hands. Bay, brown, chestnut, and black are the most common colors; but grays, roans, and duns are found.

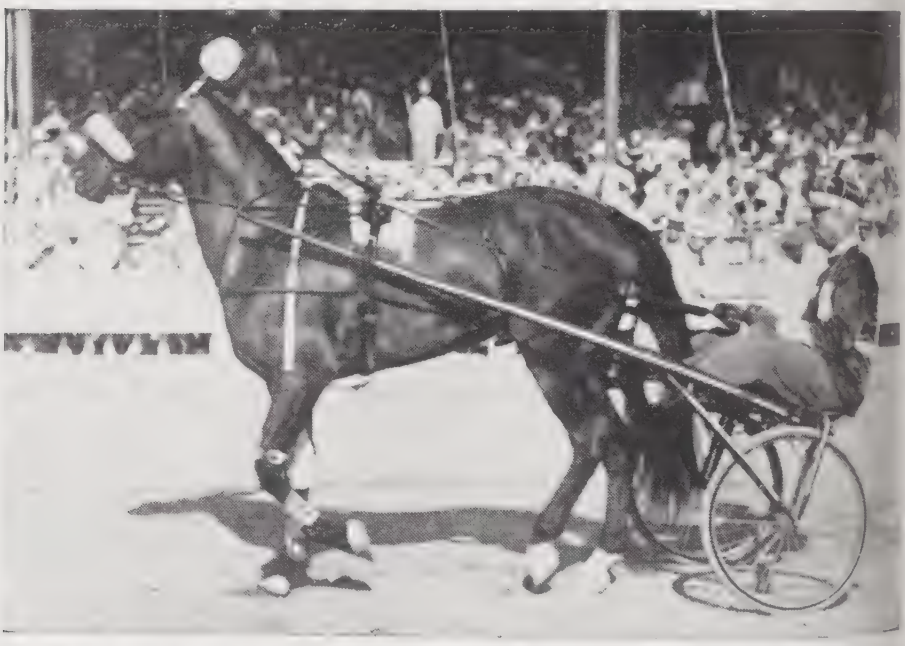


Fig. 364. Billy Direct, the Standardbred stallion that holds the mile pacing record at 1:55. True to Standardbred characteristics, Billy Direct shows more substance and ruggedness than most Thoroughbreds. (Courtesy United States Trotting Association.)

Though possessing a common ancestry, some families produce a much larger proportion of pacers than others. Many individuals show speed at both gaits. Shoeing and training are also important factors in determining whether an animal shall be a trotter or a pacer.

Adaptation and Use

As previously indicated, the Standardbred was primarily originated as a trotting horse and for the purpose of providing a superior road horse in the days of the horse and buggy. He was first put under the saddle and eventually into harness hitched to a sulky. With the coming of improved highways and the auto-

e, the progressive breeders, ever alert to new developments, d their attention almost exclusively to the production of a v harness race horse—either at the trot or the pace. The ness and stamina of the Standardbred is unexcelled, thus ing him to race heats wherein it is necessary that he go fter mile at top speed. Animals of this breed are also exhib- s harness horses in the great horse shows of the land.

The early foundation animals of the Standardbred contrib- to the development of the American Saddle Horse and the essee Walking Horse. Many hunters and cavalry horses are f Standardbred extraction. It may be said that the Stand- ed has proved to be a valuable utility horse—animals of extraction having speed, endurance, and a tractable dis- on.

nt Status of the Breed

The present mile trotting record of 1:55¼ was established 38 by Greyhound, a gelding. Billy Direct, a stallion, holds the pacing record at 1:55.

The Standardbred breed has the unique distinction of being f the few breeds of livestock that the United States has ted rather than imported. Many good specimens of the have been shipped to Russia, Austria, Germany, and Italy. t is quite likely that new harness race tracks will be de- ed; and with their development, a limited increase in ers of Standardbreds may be expected. Further improve- s in both conformation and speed may be expected also.

TENNESSEE WALKING HORSE

Today the Tennessee Walking Horse is synonymous with the ation Walking Horse, as the latter show-ring classification nstituted by this one breed. In the early formative period of reed, animals of the walk, running walk, canter variety were red to as the Plantation Walking Horse because the southern rs and overseers used this type of animal in riding over estates daily. They liked these animals because of their ina and comfortable gaits.

n and Native Home

Although the breed registry association is very recent, the essee Walking Horse has been at home in the Middle Basin nnessee for more than a hundred years. Like other American l creations, the Tennessee Walking Horse is of composite

origin. Yet, through constant breeding and selection, distinct characteristics evolved, molding the horse into an entity of its own. The sturdy native saddle stock of Tennessee accompanied the early settlers from Virginia. According to the best authorities, the breed represents an amalgamation of the Thoroughbred, Standardbred, Morgan, and American Saddle Horse breeds, together with whatever else may have constituted the native stock. Thus, throughout a century or more of meticulous breeding, the Tennessee Walking Horse has come to possess some of the endurance and upstanding qualities of the Thoroughbred, the substance and sturdiness of the Standardbred, the graceful lines and docility of the Morgan, and the style and beauty of the American Saddle Horse.

The real "patriarch," or foundation, sire of the Tennessee Walking Horse, was a stallion known as Allan, sometimes called "Black Alan" because of his color. This horse, of mixed Standardbred and Morgan ancestry, foaled in 1886, proved to be a progenitor of remarkable prepotency when crossed on native



Fig. 365. Midnight Mist, two-year-old Tennessee Walking Horse mare, owned by Charles Scheuerman, Mobile, Alabama. (Courtesy of the breeder, Harlinsdale Farm, Franklin, Tennessee.)

res. Moreover, his offspring carried on. Thus, in many re-cts, the origin of the Tennessee Walking Horse is not unlike development of the Morgan.

nessee Walking Horse Characteristics

In comparison with the American Saddle Horse, the average mber of the Tennessee Walking Horse is larger, stouter, and re rugged. He is plainer about the head, shorter necked, carries head lower, and possesses more massiveness about the body quarters. Although he has less style and elegance, the Ten-see Walking Horse excels the American Saddle Horse when it nes to temperament and disposition. He has been referred to he "gentleman of the equines."

The Tennessee Walking Horse averages around 15-2 hands height and will weigh from 1,000 to 1,200 pounds. A great ay of colors exist, including sorrel, chestnut, black, roan, te, bay, brown, grey, and golden. White markings on the feet legs are common.

The three gaits characterizing the breed are all natural gaits. ey are "free and easy" and are called the flat-foot walk, the ning walk, and the canter. Particular emphasis is placed upon running walk, an "all-day" gait which is executed at a speed six to eight miles per hour. It is started like the flat-foot walk is a diagonally-opposed foot movement. As the speed is in-ased, the hind foot usually oversteps the front track from a to as many as eighteen inches. This gives the rider a gliding sation.

aptation and Use

Although the Tennessee Walking Horse arose as the busi-s or plantation horse of Tennessee and the South, it is now gely a pleasure horse. Because of its gentle manners and easy ts, it is an ideal horse for the amateur or the person who rides requently. The experienced horseman, likewise, enjoys these ne traits.

esent Status of the Breed

The Tennessee Walking Horse has had a rapid rise in fame l numbers. With greater numbers of pleasure horses inevitable, right future is assured for the breed.

IE THOROUGHBRED

The term "thoroughbred" is applied properly only to the eed of running race horses developed originally in England.

It should not be confused with nor used synonymously with the designation "purebred," an adjective used to denote the pure lineage of any breed of livestock regardless of class or breed. Today the Thoroughbred has become the equine synonym for speed and racing quality.

Origin and Native Home

The history of the Thoroughbred, as we think of it today, had its beginning in the seventeenth century, though the oriental lineage of the breed is as old as civilization itself. The nature of man being what it is, there has been racing wherever there were horses. However, the real molding of the fleet light horse in England became a necessity with the shift from medieval warfare—in which the fighting unit consisted of a mounted knight in full armour—to the use of arrows and finally gunpowder. Speed and stamina became imperative. Simultaneously, interest in horse racing in England was greatly accelerated. As early as the reign of Henry VIII, a royal stud was established.

The real impetus to the development of a superior English running horse, however, had its beginning under Charles II, who reigned from 1660 to 1685. King Charles imported a number of outstanding Barb mares for the royal stable. Upon the descendants of this improved foundation stock were subsequently crossed three immortal stallions known respectively as: the Byerly Turk, imported in 1689; the Darley Arabian, imported in 1706; and the Godolphin Arabian, brought from Paris in 1724. From these three illustrious sires sprang three male lines: Matchem, tracing to the Godolphin Arabian; Eclipse, tracing to the Darley Arabian; and Herod, tracing to the Byerly Turk. Such was the development of the Thoroughbred, a breed predominantly of Arabian, Barb,[1] and Turk[2] extraction; though it may have in its veins the blood of the Galloway, Scotch Pony, and Highland Dun—animals used for cart or draft purposes and "heaven only knows what else."

Early American Importations

The first Thoroughbred imported to America was the twenty-one-year-old stallion Bulle Rock, by Darley Arabian and out of a dam by Byerly Turk, arriving in Virginia in 1730. Governors

[1]The Barbs were native to the Barbary States of Northern Africa. They were more rugged than the Arabian but lacked the quality, refinement, and beauty of the latter.

[2]The Turk Horse is found chiefly in Anatola and only to a limited extent in Turkey. These animals were noted for docility and beauty, but they lacked the vigor and endurance of the Arabian.

e and Sharpe of Maryland made subsequent importations ween 1747 and 1755. The Revolution interrupted the growth Thoroughbred breeding, but at its close the stream of importa- ns was re-established. New race tracks were built, and the ed became firmly entrenched in America.

roughbred Characteristics

Thoroughbreds are bay, brown, chestnut, black, or, less quently, gray in color. Irregular and conspicuous white marks not uncommon. Animals of this breed range in height from



Fig. 366. Stymie, winner of a grand total of $911,335 during his racing eer. Note the long body, deep chest, rather long legs, and high degree of lity and refinement; characteristic of the breed. (Courtesy, New York ing Association.)

to 17 hands, with an average of around 16 hands. In racing m, the Thoroughbred may weigh from 900 to 1,025 pounds. ereas stallions in breeding condition may approach 1,100 unds.

The build of the Thoroughbred shows the speed type in the treme. The body is long, deep chested, rather narrow, upstand- g, and often a bit angular. This horse possesses a high-degree quality and refinement throughout. The head is small and well

proportioned, with a straight face, small neat ear, and fine throttle. The shoulders and pastern are sloping, and the thigh and quarter are powerfully muscled. The temperament is active and energetic, being of the "racy" or highly nervous variety. The action of most Thoroughbreds is characterized by going low and pointed at the trot but executing the gallop or run to perfection.

Adaptation and Use

As a running race horse, the Thoroughbred is without a peer. However, many excellent horses of straight- or part-Thoroughbred breeding have excelled as gaited saddle horses, stock horses, polo mounts, hunters and cavalry mounts. No other breed of horses has found such diverse use and adaptation. Because of the almost incredible adaptation of the Thoroughbred and the use of his blood in producing new breeds, the breed has been referred to as the "esssential oil of horse flesh."

It must be realized, however, that many of the new breeds that evolved from a Thoroughbred foundation have now reached such a high state of perfection that an out-cross to the Thoroughbred might now be a step backward. Such is the status of the American Saddle Horse, the Tennessee Walking Horse, and the Standardbred—when it comes to their respective performances as three- and five-gaited park hacks, plantation walking horses, and harness racing. But until other or new breeds become better adapted and more important, the blood of the Thoroughbred will continue to predominate in the production of stock horses, polo mounts, hunters, and cavalry mounts.

Present Status of the Breed

Today, the race crowds are bigger than ever. New race tracks are being developed and pari-mutuels are being permitted in more and more states. These developments, together with the unquestioned value of the Thoroughbred for cross-breeding purposes, assure the breed a bright future. The U. S. and world records for Thoroughbreds at some of the popular American distances are given in the accompanying summary.

SUMMARY OF
UNITED STATES AND WORLD RECORDS FOR THOROUGHBREDS AT POPULAR AMERICAN DISTANCES

Distance	Time	Date record established	Name of horse	Age of horse	Weight carried (pounds)	Track
6 furlongs (or ¾ mile)	1:08-1/5	1950	Bolero	4 year	122	Golden Gate Flds., Albany, Cal.
6½ furlongs (on straight course)	1:14-2/5	1938	Porter's Mite	2 year	119	Belmont Park, N. Y.
1 mile	1:33-3/5	1950	Citation	4 year	130	Golden Gate Flds., Albany, Cal.
1⅜ mile	2:14-1/5	1920	Man O'War	3 year	126	Belmont Park, N. Y.

THE WELSH PONY

The Welsh breed is especially recommended for use by older children who have outgrown the use of a Shetland—children up to fifteen years of age.

Origin and Native Home

The Welsh pony is native of the rough mountainous country of Wales. Here for unknown generations, probably since Saxon times in England, these horses have ranged in bands, living a "vagabond existence" on the sparce vegetation. Under these conditions, only the more rugged, thrifty, and agile animals survived. In more recent years, improvement has been wrought by annually rounding up the semi-wild, nomadic bands and selecting the stallion leader for each.

Early American Importations

The first Welsh ponies to be imported to America of which there is record were twenty head brought over by George E. Brown of Aurora, Illinois. Subsequent but infrequent importations followed.



Fig. 367. Shooting Star, grey Welsh Pony stallion, at twenty-eight years of age. He is considered by many leading judges to be the best Welsh pony of all time. Note that the build of this horse resembles that of a miniature coach horse, being more upstanding than the Shetland. (Courtesy, C. K. Bassett, Buffalo, New York.)

elsh Pony Characteristics

Present-day Welsh mountain ponies are usually gray, roan, ck, bay, brown, and chestnut; though cream, dun, and white ors are found. Piebalds, skewbalds, and animals with excessive ite markings are objected to.

Representative animals range from 10 to 12 hands in height d weigh less than 500 pounds. In build, the modern Welsh pony y be described as a miniature coach horse, being more upstand- g than the Shetland. Individuals of this breed should possess od heads and necks, short coupling, plenty of muscling, and ostance of bone; and with it all, there should be considerable eed and action at the trot and unusual endurance.

laptation and Use

The Welsh Pony is unexcelled as advanced children's mounts d for such other general use as is within their size limitations. attractive, properly appointed pair is well adapted to ladies e. Many Welsh ponies have also been used in the coal mines of rope. Some excellent hunters, polo ponies, and hacks have rried a percentage of Welsh breeding. Ponies shown in the elsh classes in American horse shows are frequently Hackney nies or Hackney-Welsh crossbreds.

esent Status of the Breed

Although it is not likely that great numbers of Welsh Ponies ll ever be found in America, they will always fill a need. With e greater emphasis on physical fitness following World War II, is quite likely that present numbers in America will be creased.

CHAPTER XXXVIII

BREEDS OF DRAFT HORSES

The breeds of draft horses here considered are the Belgian, Clydesdale, Percheron, Shire, and Suffolk. Regardless of the distinct breed trademarks and the virtues ascribed to each breed, all are characterized by great massiveness—their adapted field of utility being the drawing of heavy loads at a comparatively slow gait, usually at the walk.

Power rather than speed is desired. In order to possess this power, the draft horse should be blocky or compact, low set or short legged, and sufficiently heavy to enable him to throw the necessary weight into the collar to move a heavy load and at the same time maintain a secure footing. This calls for a horse around 16 to 17 hands in height and weighing not less than 1600 pounds.

All of the modern draft breeds of horses, regardless of color or breed or later infusions of other breeding, rest upon a Flemish foundation—the large, coarse, black, hairy, and sluggish horse which, from a very early time, existed in the low-lying sections of what is now Belgium, France, Holland, and Germany. Thus the draft breeds were of European origin, whereas the light-horse breeds were of Oriental extraction.

Battle chariots, drawn by heavy horses and used to convey armored troops who fought on foot, were encountered by the Roman legions under Caesar when he invaded England in the year 55 B. C. Later, these ponderous beasts, imposing in height and bulk, were known as the "great horses of the Middle Ages."

These animals were the cavalry mounts of the heavily armored knights when they rode forth to battle for king and country and at times to enforce their views of religion upon unbelievers in general and Mohammedans in particular. These animals had to be large and powerful in order to carry the immense weight of themselves, their arms, and their armor—including eventually the armor of both the horse and the rider. Often the combined weight of their load was up to 450 pounds.

Finally, in the nineteenth century, when the use of armor in warfare was abandoned after invention and adoption of gunpowder by the fighting nations and when the development of

culture and commerce received new impetus, the "great se" served as the foundation for the draft breeds as we know n today. Lighter horses came into use for riding and the eat horse" was relegated to pulling the cart and the plow to hauling timber, coal, and other industrial materials.

LATIVE POPULARITY OF BREEDS OF DRAFT HORSES

Table 73 shows the 1949 and total registrations to date of various breeds of draft horses. As may be noted, none of the ft registry associations are doing much business.

TABLE 73

1949 AND TOTAL REGISTRATIONS OF DRAFT HORSES IN UNITED STATES BREED ASSOCIATIONS[1]

reed	1949 registrations	Total registrations
gian	300	63,010
cheron	253	248,062
desdale	33	25,493
e	16	21,969
olk	4	2,576

[1] *New England Homestead*, Springfield, Mass., Sept. 23, 1950, 123, 40.

E BELGIAN

The Belgian breed has made marked progress in this coun- considering that so few animals were imported prior to the inning of the twentieth century. Belgian stallions have been ecially valuable in improving the draftiness of the native k on which they have been crossed.

gin and native home

The Belgian breed originated in Belgium from which coun- it derives its name. The agricultural needs of this low-lying ntry were such as to require a horse of size and bulk. So far s known, no oriental blood was fused with the native stock. us it may be concluded that the Belgian breed is directly and lusively descended from the old Flemish ancestry—indigenous he country of their origin. Even today, the great massiveness he Belgian breed more nearly resembles the Flemish horse n does any other breed.

In their native country, the breeding of Belgian draft horses romoted by the government, which annually awards prizes subsidies to the best animals in the various provinces. Also, lions that stand for public service must be approved by a com- sion appointed by the government.

Early American importations

The first importation of the Belgian to the United States was made in 1886 by Dr. A. G. Van Hoorebeke of Monmouth, Illinois, but the breed attracted little attention until 1900. Thus the introduction of the breed was more recent than that of the Percheron, Clydesdale, and Shire. Despite their late entry into this country, however, Belgians have given a good account of themselves. They rank next to the Percheron numerically at the present time.

Belgian characteristics

Bay, chestnut, and roan are the most common colors, but browns, grays, and blacks are occasionally seen. Many Belgians have a flaxen mane and tail and a white-blazed face. Mature stallions stand from 15-2 to 17 hands in height and weigh 1,900 to 2,200 pounds or more.

The Belgian is noted for its draftiness—being the widest, deepest, most compact, most massive, and lowest set of any draft breed. Formerly, the breed was likely to be severely criticized for having small round hoofs, round bone, short thick



Fig. 368. Betty, Grand Champion Belgian mare of the 1948 American Belgian Show (Ohio State Fair), owned and exhibited by W. G. Harkness & Son, Sandusky, Ohio. Note the draftiness of this mare. (Courtesy, Belgian Draft Horse Corporation.)

s, and lack of refinement. But it is to the everlasting credit he American breeders that these defects have been very ely overcome. The present popularity of the breed attests to e improvements.

The Belgian is extremely quiet, docile, and patient. The ac- is powerful, though less springy and high than found in the esdale and Percheron. Because of their great width in front, y Belgians roll or paddle somewhat at the walk.

CLYDESDALE

Like all classes and breeds of livestock of Scotch origin— uding Ayrshire, Aberdeen-Angus, Galloway, and Highland e and Cheviot and Black-faced Highland sheep—the Clydes- breed of horses is distinctive for style, beauty, and action.

in and native home

This Scotch breed of draft horses derives its name from the ey of the River Clyde, an area popularly known as Clydesdale, ted in the County of Lanark, Scotland.

The breed is of mixed origin, and the early history is more ess obscure. It is probable that the blood of both Flemish English horses entered quite largely into the breed during early formative period. Rather frequent importations of es of Flemish extraction from England and the low countries e made, thus giving the Scotch Clydesdale and the English re and Suffolk similar ancestry. However, the breeders in respective countries had very different notions as to what tituted a desirable draft animal, and their selections were erned accordingly, the Scotch placing particular emphasis h style and action.

ly American importations

The first Clydesdales brought to North America were prob- imported into Canada by the Scotch who settled there. Be- ning in the early 1870's Clydesdales were imported into the ted States, both via Canada and direct from Scotland.

desdale characteristics

The Clydesdale is not so heavy as the Shire, Belgian, or cheron. Average representatives of the breed are also more gy and lack the width and compactness of the other draft eds. Mature stallions in average condition weigh from 1,700 ,900 pounds and stand from 16 to 17 hands in height.

No other breed of draft horses equals the Clydesdale in style and action. The breed is noted for a prompt walk, with a good snappy stride and a short trot, and the hocks are well flexed and carried close together. Good clean, flat bone; well-set, fairly long and sloping pasterns; and a moderate amount of fine feather or long hair at the rear of the legs below the knees and hocks are characteristic. Sometimes in America, the breed has been criticized for lack of width and depth of body and for having too much



Fig. 369. Linton Marcellus, a Chicago International Grand Champion Clydesdale Stallion. No other breed of draft horses equals the Cydesdale in style and action. (Courtesy, Horse Association of America.)

feather and too much white. Usually, Americans do not fancy too much white on the face and legs in any breed of horses, and they object to the feather or long hair about the fetlocks because of the difficulty in keeping the legs and feet free from mud and snow. Bay and brown with white markings are the most characteristic colors, but blacks, grays, chestnuts and roans are occasionally seen.

For show use in a six-horse hitch on the tanbark, a well matched, carefully trained, and expertly handled group of Clydesdales are unexcelled. Their flowing white fetlocks and high action give them a picturesque appearance.

E PERCHERON

The Percheron is the most widely distributed of all draft eds. Although all heavy horses have fought a losing battle inst mechanization, it is quite likely that some Percherons continue to survive the vicissitudes of time.

gin and native home

The Percheron horse originated in northwestern France in ancient district of La Perche, an area about one-fifteenth the of the state of Iowa. The native stock was primarily of nish extraction upon which there was a subsequent and er liberal infusion of Arab blood.

Although early records are lacking, it is known that with defeat of the Saracens (the Moors from North Africa) at rs and Poitiers, France, in 732 A. D. by Charles Martel, the b, Barb, and Turk horses upon which the Moors were nted—mostly stallions as was the custom of the day—fell the hands of the Franks and were eventually distributed ughout the country. The successful Crusaders of the twelfth, teenth, and fourteenth centuries also brought back stallions poils of war from Palestine, and this again furnished a direct gh unplanned infusion of Oriental blood. Thus, on a cold d base, the Flemish horse, repeated top crosses of Oriental d were made. Finally, in about 1870, a systematic effort was le to transform the mixture into a true type. Eventually, the cheron breed was evolved, and the Percheron Society of nce was organized in 1883.

ly American importations

American importations of Percherons began about 1840, but vas not until the early 1850's that any great numbers came r. Brilliant 1271, a black stallion foaled in 1877 and imported 881, is recognized as the most famous and prepotent animal the breed ever imported. Other importations followed, and center of interest in the breed came to be located in the Corn t, an area which it still dominates.

cheron characteristics

Typical Percheron colors of today are black or gray (the lat- being a probable Arab inheritance); but bays, browns, chest- s, and roans are occasionally seen. Fully 90 per cent, however, black or gray.



Fig. 370. Don Again, Chief Percheron Sire of Lynnwood Farm, Carmel, Indiana. The Percheron is noted for its handsome, clean-cut head, good action, excellent temperament, and longevity. (Courtesy, Percheron Horse Association of America.)

Mature stallions stand from 16-1 to 16-3 hands in height and weight from 1,900 to 2,100 pounds. In size, the Percheron is intermediate between the larger Shires and Belgians and the smaller Clydesdale and Suffolk. In comparison with other draft breeds, the Percheron is noted for its handsome, clean-cut head; good action (being surpassed in style and action only by the Clydesdale); excellent temperament; and longevity.

THE SHIRE

England has originated and developed two breeds of draft horses, the Shire and the Suffolk. Originally the Shire was known by various names, such as the Great Horse, War Horse, Cart Horse, Old English Black Horse, Lincolnshire Cart Horse, etc.

Origin and native home

The Shire breed was originated on the low, marshy lands of east-central England, particularly in Lincolnshire and Cambridgeshire. Hence comes the name "Shire."

The great size and bulk of this breed is derived directly from "Great Horse" of the Middle Ages, of which Shires are held be the nearest living reproductions. As previously indicated, "Great Horse" was in turn descended from the ponderous ck Flemish horse which existed in Great Britain long before Christian era, more than two thousand years ago.

In the year 1066, England was conquered by an army of rmans led by William the Conqueror. This marked the begin- g of improvement in the native draft stock of England. Im- tations of horses followed from France, Germany, and the low ntries. Centuries later, Robert Bakewell (1726 to 1795), own as the first great improver of livestock, contributed to the ther improvement of the Shire—as well as to that of Leicester ep and Longhorn cattle. Bakewell imported several mares m Holland which were mated to native stallions, and he ected and perpetuated the better offspring therefrom. During kewell's era, the Shire was being molded as a draft horse for riculture and commerce, the use of armor in warfare having n abandoned.

Thus the development and improvement of the Shire breed edates that of any other breed of draft horses. This fact gely explains the present day uniformity and prepotency of breed when crossed on common stock.

rly American importations

Shire horses were first imported to London, Ontario, in 1836. gray stallion, known as Columbus, was imported to Massachu- ts prior to 1844. Small scattered importations followed, but no eat numbers came over until 1880. In 1887, more than four ndred Shires were imported. Very early, horsemen became are of the fact that Shire stallions were unsurpassed in their lity to beget draft horses from mares lacking in size and bone.

ire characteristics

The Shire, as known today, is a much larger horse than was ancestor used by the mounted warriors of old. He is equaled weight only by the Belgian. Shire stallions in fair condition ighing 2,000 pounds or over are comparatively common. In ght, representatives of this breed stand from 16 to 17-2 hands. ey are less compact or more rangy than the Belgian and taller an any other draft breed.

In the past, the breed has been faulted for its heavy bone l feather, lack of quality and refinement, its shelly-textured



Fig. 371. Little Duke, winning 2-year-old Shire stallion, exhibited by Lou Shattuck, Horseshoe Ranch, Toppenish, Washington. The Shire is taller than any other draft breed. (Courtesy, Lou Shattuck, Toppenish, Washington.)

hoof, its sluggish temperament, and its excessive white markings; but breeders have shown marked progress in overcoming these objections in recent years.

The common colors are bay, brown, and black with white markings; although grays, chestnuts, and roans are occasionally seen.

THE SUFFOLK

The Suffolk is unique among draft breeds in that (1) it was developed exclusively as a farm work horse and not for use on city streets, and (2) all animals of the breed are chestnut in color, this color being recessive. Often the breed is referred to as the Suffolk Punch, a name descriptive of the "punched-up" conformation of the old-fashioned animials of this breed.

Origin and native home

The native home of the Suffolk is in the county of Suffolk, on the eastern coast of England, bordering the North Sea. The origin of the breed is unknown, but horses of similar character-

cs are known to have existed in Suffolk for many centuries. nough proof is lacking, it is claimed that Norman stallions e crossed on the native mares of Suffolk County five hundred rs ago. It has also been conjectured that the chestnut color he breed is due to a cross with Norwegian horses brought in the early Norse invaders. It is known, however, that from a y early period these animals were produced in Suffolk by ners and for farming purposes. It is said that every well-bred folk of today is descended from a bright-colored chestnut lion foaled in 1768 and owned by a Mr. Crisp of Ufford.



Fig. 372. Riddlesworth Viscount, Senior Suffolk Stallion at Upwey m, Woodstock, Vermont. Suffolk horses are distinguished by their chest- color and chunky build. (Photo by M. E. Ensminger.)

Early American importations

Suffolks were first imported into the United States in the early eighties and have been imported since then in small numbers. In the first place, they are not available in large numbers, the area devoted to their production being rather limited and there being an active demand for them at home and in the British Dominions.

Suffolk characteristics

The Suffolk is smaller than other drafters. Average animals weigh from 1,600 to 1,800 pounds and range in height from 15-2 to 16-2 hands. Occasionally, a mature stallion may weigh 2,000 pounds or more, but such weight is not characteristic of the breed.

Suffolk horses are always chestnut in color, varying from light to dark, often with cream-colored mane and tail. When white markings occur, they are likely to be unobtrusive. Aside from color, the distinguishing characteristics of the breed include their close-to-the-ground and chunky build, smooth rotund form, and clean-boned leg devoid of the feather characteristic of the other two British draft breeds.

Although small in size, the Suffolk is celebrated for his courage and willingness to work and his excellent disposition. The story goes that in their native land the courage and strength of Suffolk horses was often tested by contests involving the hitching of individual animals or teams to an immovable object, such as a tree—with the winner being determined by the number of efforts the animal or animals made in throwing themselves into the collar and pulling with all their might at the command.

The Suffolk has never gained wide popularity in this country, primarily because of his lack of size and lightness of bone.

CHAPTER XXXIX

SELECTING AND JUDGING HORSES

As with other classes of farm animals, any one of or a com-ation of all four of the following methods may serve as a basis selecting horses: (1) individuality, (2) pedigree, (3) show-g winnings, and (4) production testing.

Perhaps at the outset it should be said that each method of ection has its own particular place. Certainly the progressive seman will make use of all of them. One must also be aware of fact that environment, including feeding and training plays remendously important part in the individuality and perform-e of a horse.

LECTION BASED ON INDIVIDUALITY

As is well known, the type or individuality of the horse ies according to the specific functions that the animal is sup-ed to fulfill—whether it be racing, saddle, heavy harness, polo, . In considering individuality or type, one usually more or less omatically examines the performance of the individual at the e of work for which he is bred, adapted, and selected. That is, addition to studying the individual excellence in body conform-on, the animal is observed in action. Thus the saddle horse is died while executing the gaits; if old enough, the running rse is actually timed on the track; and the draft horse is put a test of drawing a heavy load.

Selection followed by mating of the "best to the best," which merely selection based on individuality, has long been the ncipal tool through which man has brought about the improve-nt of the horse. Following domestication, certain animals were osen for breeding purposes while others were slaughtered and en. In no case has this method of improvement achieved more cess than with this particular class of livestock.

That selection based on individuality has been effective over ong period of time in developing distinct types of horses well apted for specific purposes is self-evident. Thus from one or a v wild types of horses—by selecting individuals for their lity to perform certain types of work while giving considera-n in some instances to their style and beauty—man has de-

veloped five distinct types of horses: draft, heavy harness, light harness, saddlers, and ponies. Thus the Great War Horse and his descendant, the draft horse, were selected for their ability to carry and draw heavy loads—a characteristic requiring heavy, compact, low-set, heavily muscled, and heavy-boned animals with a relatively docile and quiet type of temperament. By way of contrast, the horses developed by the Bedouins of the desert—a warring tribe whose safety often depended upon the speed of their escape—and later used as foundation animals for the race horse, were selected for a lithe, lean, relatively long-muscled, and light-boned animal with a quick, nervous disposition. Still other qualities, especially beauty and high action, were sought in the heavy harness horse; and the saddle horse was selected primarily because of the ease with which he carried the rider.

Selection on the basis of individuality and performance alone is still the best single method for obtaining suitable utility horses, whether they be used for draft, heavy-harness, light-harness, saddle, or pony purposes. In other words, the individuality of the horse, its phenotype, is closely correlated with its performance. However, if the animals are selected for breeding purposes, additional criteria should be considered.

SELECTION BASED ON PEDIGREE

The Arabians were the first livestock breeders to trace the lineage of their animals, often memorizing many generations of the pedigree. Moreover, they accorded particular importance to the dam's side of the heritage, a condition that still prevails in certain breeds of livestock today as evidenced by the family names tracing to certain great females many generations removed.

If the pedigree is relatively complete in terms of records of performance (speed, show winnings, etc.) of the ancestors, particularly those close up, it can be of very great usefulness in providing a safer basis for selection. A pedigree of this type is of value in predicting (1) the usefulness of the individual (whether it be for racing under the saddle or jumping, etc.) and (2) the probable prepotency as a breeding animal.

Pedigree selection is of special importance where animals are either too thin or so young that their individual merit cannot be ascertained with any degree of certainty. Then, too, where selection is being made between animals of comparable individual merit, the pedigree may be the determining factor.

ECTION BASED ON SHOW-RING WINNINGS

Breeders of draft and pleasure horses have long used show- records as a basis of selection. Because training plays such mportant part in the performance and show-ring winnings leasure horses, however, it is likely that this basis of selec- is less valuable from a breeding standpoint than with any r class of farm animals. At the same time, the show record be a most valuable criterion in indicating the utility value ıe horse.

ECTION BASED ON PRODUCTION TESTING

Although selection based on progeny testing is the most in- ble tool available to the horse breeder, it must be pointed that, fine as it is, the following limitations exist:

1. Because of relatively few offspring, it is difficult to ap- it to females.

2. Even with males, a progeny testing rating cannot be ob- ed until late in life, after sufficient offspring have been born have reached an age when they can be tested.

3. There is the hazard that the stallion being tested will be bred to a few select mares and that only the top offspring be tested.

4. Training and feeding plays such a major part in horses it is always difficult to separate out environmental from editary influences.

Performance testing is easier to apply because it is an in- dual matter. In fact, most race horses used for breeding pur- es are first performance tested on the track.

Perhaps it might be added that the progressive breeder will tinue to use all four methods of selection: individuality, pedi- e, show-ring winnings, and either performance testing or geny testing, but with increasing emphasis upon the latter hod.

DGING HORSES

Accomplished stockmen generally agree that horses are the st difficult to judge of all classes of farm animals. In addition onsidering conformation—which is the main criterion in judg- other farm animals—action, and numerous unsoundnesses of paramount importance.

Parts of a horse

Before being able to arrive accurately at an ideal or standard of perfection, the amateur horseman must first master the language that describes the parts of an animal. Figure 373 sets forth this information.

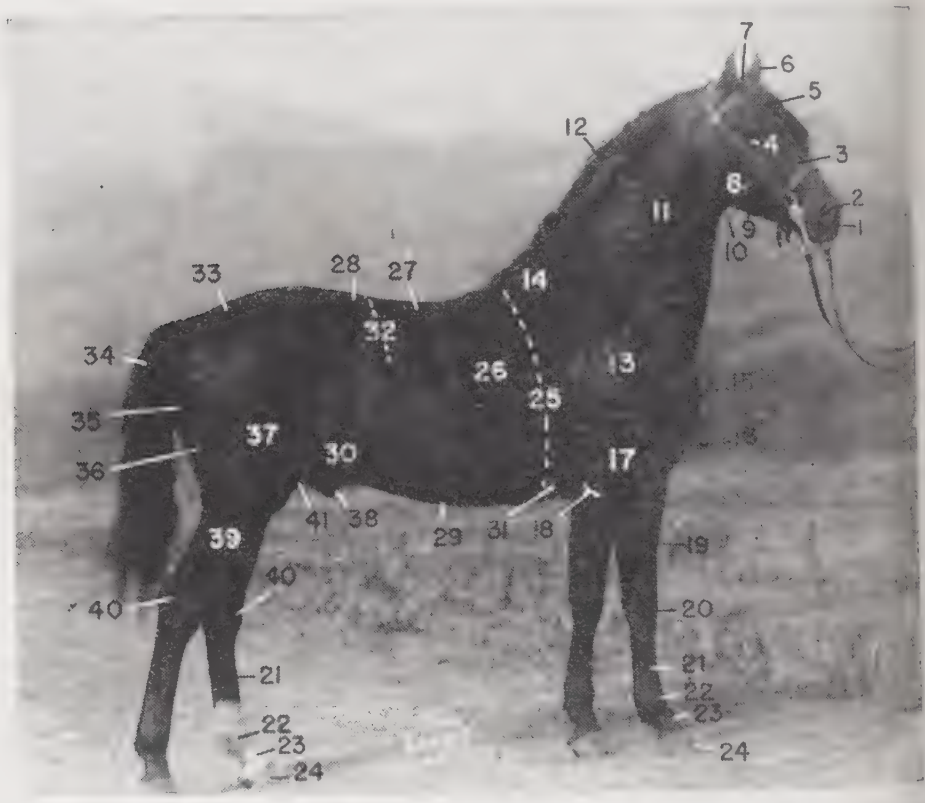
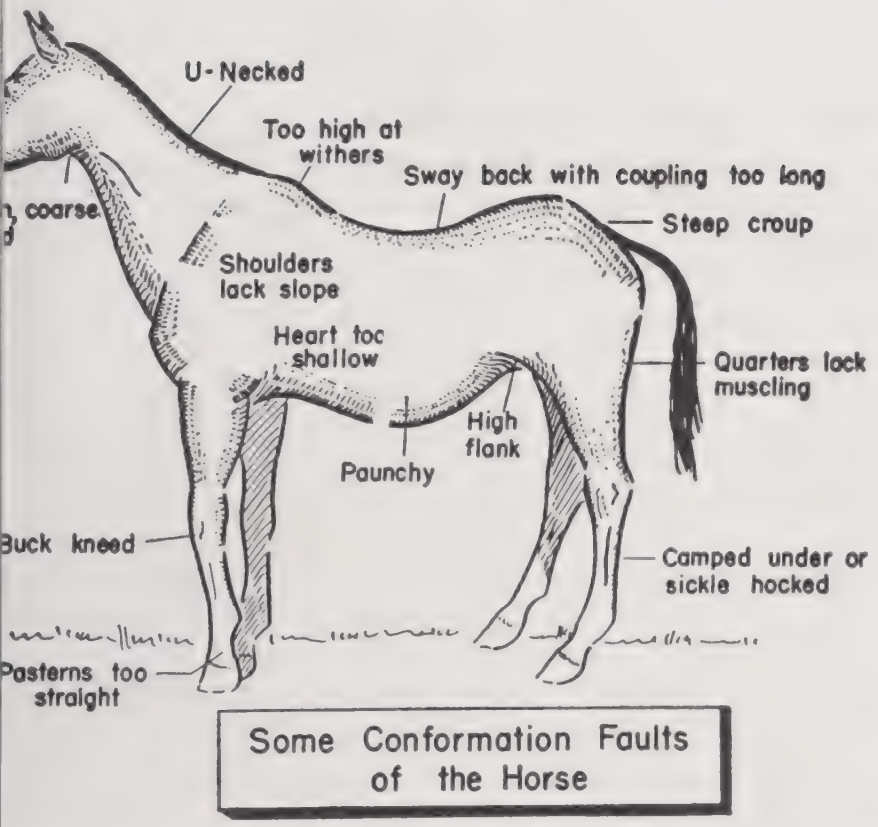


Fig. 373. Parts of a horse. The amateur horseman must first master the language that describes the parts of an animal. The Morgan horse shown above is Gay Mac 7988. (Courtesy, Morgan Horse Club.)

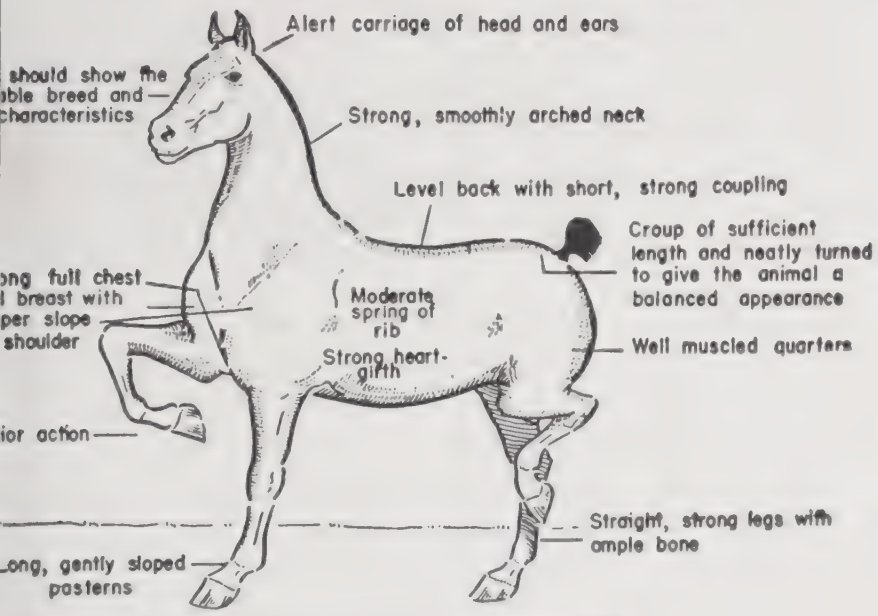
1. Muzzle
2. Nostrils
3. Face
4. Eye
5. Forehead
6. Ear
7. Poll
8. Cheek
9. Jaw
10. Throatlatch
11. Neck
12. Crest
13. Shoulder
14. Withers
15. Point of Shoulder
16. Breast
17. Arm
18. Elbow
19. Forearm
20. Knee
21. Cannon
22. Fetlock joint
23. Pastern
24. Foot
25. Heart Girth
26. Ribs
27. Back
28. Loin
29. Underline
30. Rear flank
31. Fore flank
32. Coupling
33. Croup
34. Tail
35. Point of buttock
36. Quarters
37. Thigh
38. Sheath
39. Gaskin
40. Hock
41. Stifle

Desirable characteristics according to type and breed

A horse must first conform to the specific type which fits him for the function he is to perform. Secondly, he should be true to the characteristics of the breed that he represents. Regardless of type or breed, however, the following desirable characteristics should be present in all horses.



Some Conformation Faults of the Horse



Some Desirable Conformation Features of the Horse

ig. 374. Ideal type versus common faults. Regardless of type or breed, certain desir-characteristics should be present in all horses. The successful horse judge must be able cognize both the desirable characteristics and the common faults, and the relative im-nce of each. (Drawing by R. F. Johnson.)

GOOD HEAD, NECK AND SHOULDERS:

The head should be well proportioned to the rest of the body, refined and clean-cut, with a chiseled appearance. A broad, full forehead with great width between the eyes indicates intelligence. A straight face is usually preferable to a concave or convex profile (Roman nose), the former suggesting a timid disposition and the latter strong will power. The jaw should be broad and strongly muscled. There should be great width between large, clear eyes; and the ears should be of medium size, well carried and active. The neck should be fairly long, with greater proportionate length in light horses than in draft animals. It should be carried high, slightly arched, lean and muscular, and clean-cut about the throat latch, with the head well set on. The neck should also neatly join long, oblique, smooth shoulders. The head and neck of the animal should show sex character—boldness and masculinity in the stallion and refinement and femininity in the brood mare.

A STRONG HEAVILY MUSCLED TOP-LINE, WITH A SHORT BACK AND LOIN AND A LONG LEVEL CROUP:

The top-line should include a short, strong back and loin, with a long, nicely turned and heavily muscled croup, and a high, well-set tail. The withers should be rather clearly defined and of the same height as the hips. Good withers and oblique shoulders make for a better seat in riding horses. Moreover, a sloping shoulder is usually associated with sloping pasterns and more springy, elastic action. The back and loin muscles help sustain the weight of the rider, lift the forequarters of the horse, and strengthen the arch of the back of the horse in motion. A desirable short coupling is obtained when the last rib is close to the hip.

AMPLE CHEST AND MIDDLE:

Ample chest and middle due to long, well sprung ribs is to be desired. A deep, wide chest and large, full heart-girth—together with a good middle—provides needed space for the vital organs and indicates a strong constitution and good feeding and staying qualities. All horses should be fairly well let-down in the hind flank, though race horses in training may show much less depth at this point than other types of horses. Even with race horses, however, the extremely high-cut, so-called "wasp-waisted" ones will not endure heavy racing. Moreover race horses usually deepen materially in the rear flank with age or higher condition

LL-MUSCLED ARM, FOREARM, AND GASKIN:

The muscles of the arm, forearm, and gaskin should be well eloped. Since little or no fat can be placed upon the forearm gaskin, these areas are a good indication of the muscular de- pment of the entire animal, even when horses are in high dition. The powerful muscles of the croup, thigh, and gaskin e the animal ability to pull, jump, or run.

RRECT LEGS, FEET, AND PASTERNS:

There has long been a saying "no foot, no horse." After all, value of a horse lies chiefly in his ability to move, hence the essity of good underpinning. The legs should be straight, e, and squarely set; the bone should be well placed and clearly ned. The pasterns should be sloping; the feet large and wide he heels and tough in conformation.

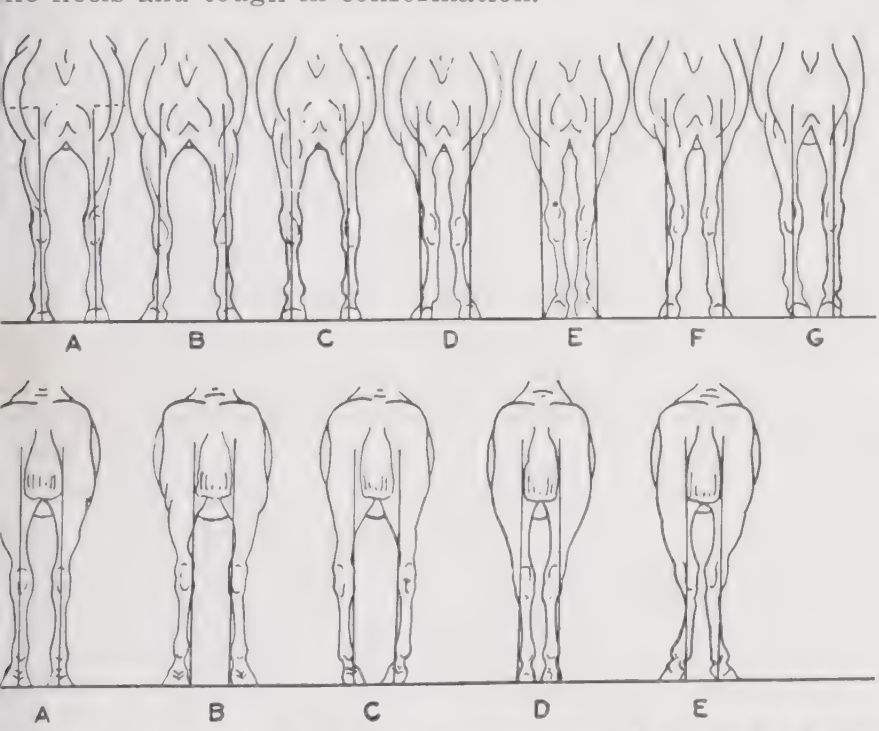


Fig. 375. The proper and faulty conformation of (top) the forelegs n viewed from the front, and (bottom) the hind legs when viewed from rear. The forelegs: A, represents correct conformation; B, splay-footed base-narrow forefeet, toe cut out, heels in; C, bowed legs; D, knock- ed, knees set close together with toes pointing outward; E, conforma- predisposing to interfering; F, knees set close together; G, pigeon-toed oe narrow—a conformation which will cause the animal to wing or w out the feet as they are elevated. The hind legs: A, represents cor- conformation; B, hind legs set too far apart; C, bandy-legged—wide he hocks and hind feet toe in; D, hind legs set too close together; E, -hocked. The direction of the leg and the form of the foot are very ortant in the horse. (Courtesy, U.S.D.A., Bureau of Animal Industry.)

The hock should be large, clean, wide from front to back, deep, clean-cut and correctly set. The knee should be deep from front to rear, wide when viewed from the front, straight, and should taper gradually into the leg. Since the hock and knee joints of the horse are subject to great wear and are the seat of many unsoundnesses, they should receive every attention.

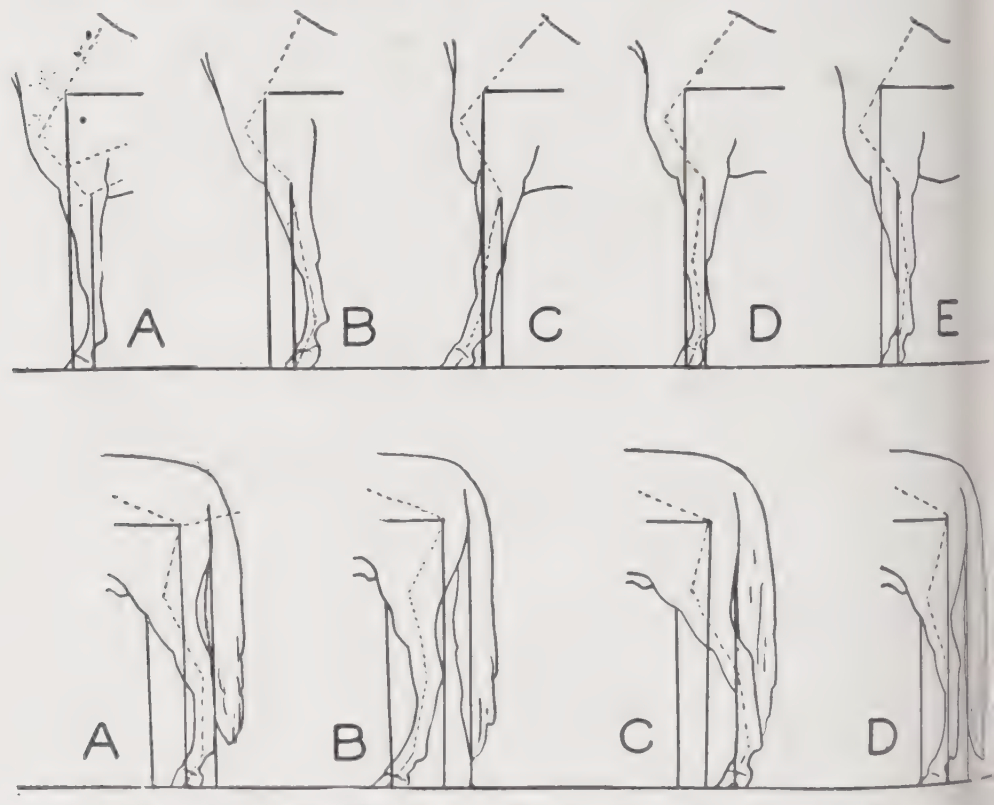


Fig. 376. The proper and faulty conformation of (top) the forelegs when viewed from the side, and (bottom) the hind legs when viewed from the side. The forelegs: A, correct conformation; B, forelegs too far under the body; C, forelegs too far advanced; D—knee-sprung or buck kneed—over in the knees; E, calf-kneed—standing with knees too far back. The hind legs: A, correct conformation; B, sickle hocked—hind legs too far under the body; C, legs set too far back; D, hock joint is too straight. The direction of the legs and the form of the foot are very important in the horse. (Courtesy, U.S.D.A., Bureau of Animal Industry.)

GOOD ACTION:

Although the degree of action of the horse will vary somewhat with the type (draft, speed, show, and saddle), the usefulness of all horses is dependent upon their action and their ability to move in various types of racing, driving, hunting, riding, polo, etc. In all types and breeds, the motion should be straight and true with a long, swift, and elastic stride.

ND:

The horse should be serviceably sound, and in the young
al there should be no indication of defects in conformation
may predispose unsoundness. The horseman must first know
recognize the normal structure and function before attempt-
to determine unsoundness. Practically speaking, an un-
dness is any deviation in form or function that interferes
the usefulness of the individual; whereas, a blemish is an
rmality which may detract from the appearance of the ani-
but which does not affect his serviceability. The latter in-
es wire-cut scars, capped hocks, etc.

er considerations in buying a horse

In addition to the desirable qualities in conformation already
nerated, there should be style and beauty, balance and sym-
ry, an abundance of quality, an energetic yet manageable
osition, freedom from vices, good wind, suitable age, freedom
disease, and proper condition. The buyer should also be on
alert for possible misrepresentations. As each of these fac-
should receive careful consideration when buying a horse,
will be discussed separately.

LE AND BEAUTY:

This has reference to the attractiveness with which the
e displays himself at all times. Good carriage of the head,
e ears, an alert active disposition, and beauty of conforma-
are factors contributing to the style of the horse. This qual-
s especially important in heavy harness, light harness, and
le horses.

LANCE AND SYMMETRY:

Balance and symmetry refers to the harmonious develop-
t of all parts. With the full development of all important
s, which are nicely blended together, the horse will present
ttractive appearance.

ALITY:

Quality is denoted by clean, flat bone, well-defined joints and
ons, refined head and ears, and fine skin and hair. Good
ity in the horse indicates easy keeping and good endurance.

ENERGETIC YET MANAGEABLE DISPOSITION:

Both sexes and all types of horses should at all times dis-
energetic yet manageable dispositions. The disposition of a
e, whether good or bad, is usually considered as being a

product of both inheritance and environment. Regardless of the cause of a nasty disposition, one should avoid purchasing such an animal. Superb manners and disposition are especially important in all types of pleasure horses.

FREEDOM FROM VICES:

Although not considered as unsoundnesses, such stable vices as cribbing, weaving, tail rubbing, kicking, stall-walking and stall-trotting, and halter-pulling do detract from the value of a horse. But vices are not confined to actions in the stall. Some horses object to taking a bit in their mouths; others are touchy about the ears or offer resistance to the crupper being placed under their tails; still others jump when an attempt is made to place a saddle or harness on their backs. Any of these traits are objectionable.

GOOD WIND:

Good wind is imperative. Defects of wind may be easily detected by first moving the animal at a rapid gait for some distance, then suddenly bringing him to a stop and listening in near proximity to the head. Unsound animals are usually noisy in breathing.

SUITABLE AGE:

The horse is usually considered as being in his prime between the ages of three and eight. Since younger horses are still growing and becoming hardened, many two- and three-year-olds do not stand up under heavy racing or other use. Although a horse's market value begins to depreciate when he reaches his eighth year, he may be useful in performing certain services until he is well over twenty years old.

FREEDOM FROM DISEASES:

In transporting a horse, there is always a possible exposure to the many ills to which he is subject. Sometimes these prove to be of sufficiently serious nature as to make working impossible at a time when the animal is most needed; and occasionally they even prove fatal. It must also be remembered that such diseases as contracted may very likely spread to the other horses on the farm and even in the community, thus exposing them to the same risk.

CONDITION:

Both productive ability and endurance are lowered by either a thin, rundown condition or an overfat and highly fitted con-

on. A good vigorous, thrifty condition is conducive to the best
k and breeding ability, and horses so fitted attract the eye of
prospective buyer. However, extremes in feeding and lack of
rcise are to be avoided in purchasing a horse for either work
breeding. It must be remembered that fat will cover up a
titude of defects. In buying valuable mares or stallions, the
chaser should insist on having a health certificate signed by
ensed veterinarian. Such examination should also show that
reproductive organs are normal and healthy.

REPRESENTATIONS:

Especially is the inexperienced man likely to encounter mis-
resentations as to age, soundness, vices, and the training
working ability of the horse. Perhaps knowing the seller as
as the horse is the best preventive of this sort of thing.

hod of examining

Custom decrees somewhat different show-ring procedure in
ging horses. Draft horses and halter classes of the light
se breeds are first examined while lined up side by side, and
r inspected while moved one at a time; whereas light horse
on classes are first examined with the entire class in action,
later lined up for close inspection.

After a judge has inspected a light horse class, both in ac-
and when lined up, it is considered entirely proper and good
es for him to request that certain animals be pulled out and
n put through their gaits. Figure 377 shows the common
hod of examining a three-gaited saddle horse.

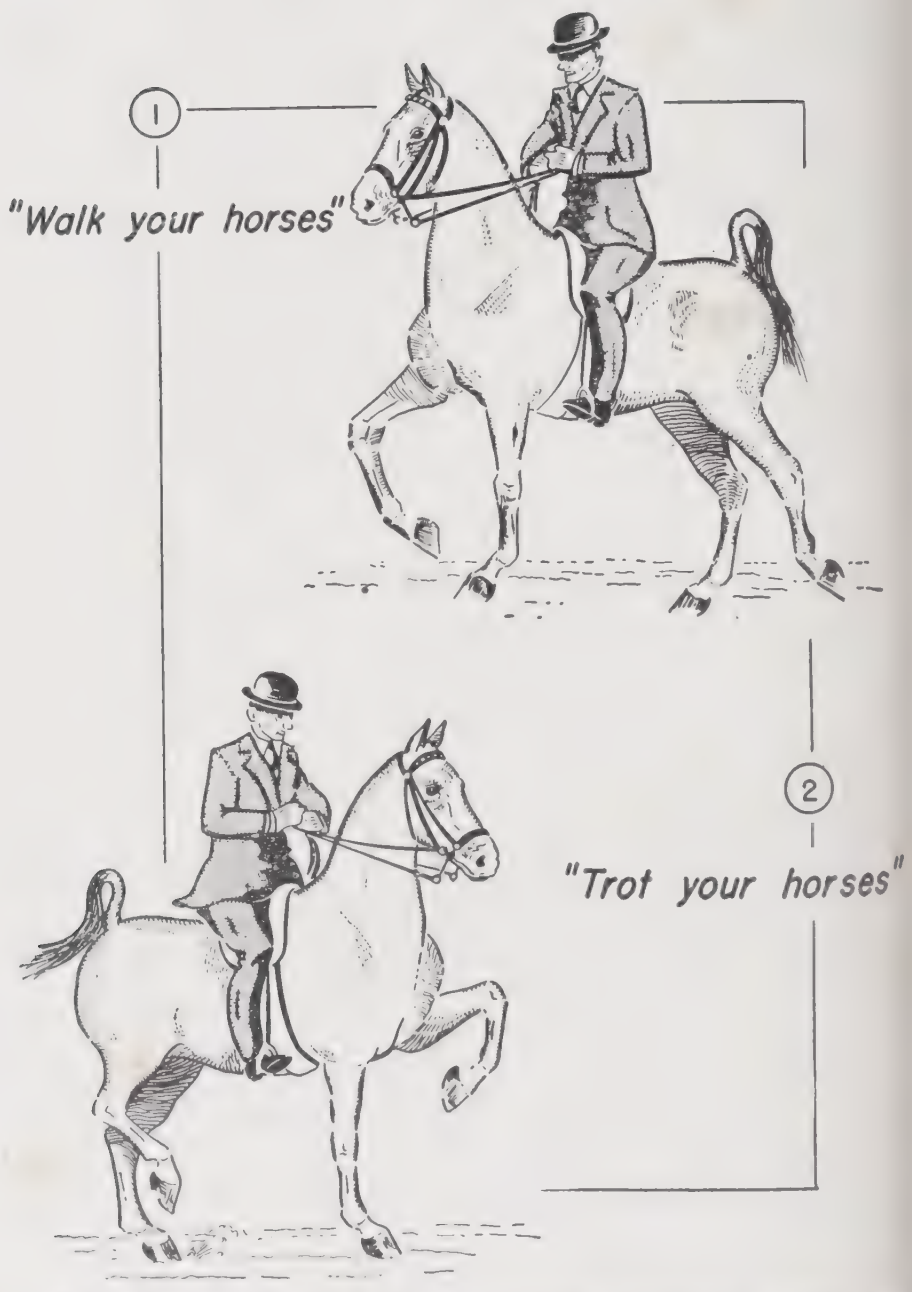
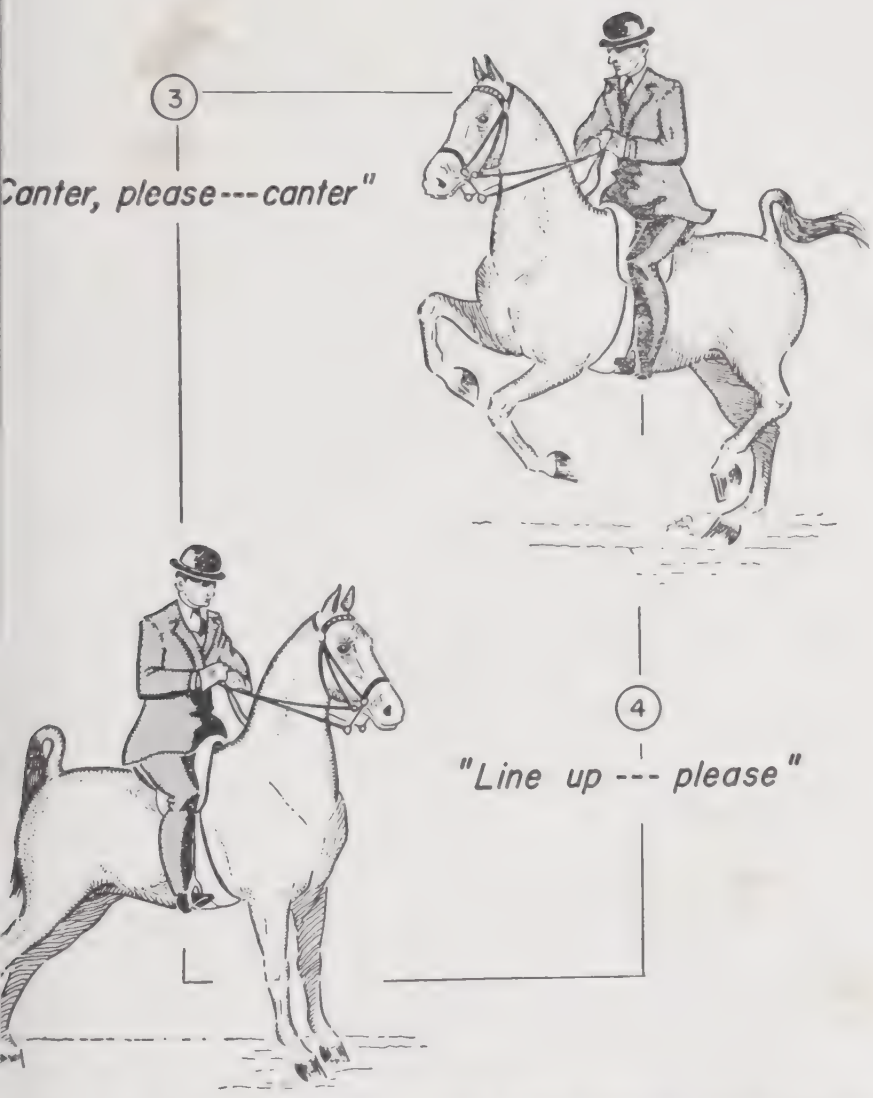


Fig. 377. Diagram showing the customary procedure in examining a three-gaited horse in the show-ring. Animal herein shown (1) walking, (2) trotting, (3) cantering, and (4) lined up. Traditionally, the judge or judges work from the center of the ring while the steward requests the riders to execute the different gaits. Three-gaited horses are expected to



, trot, and canter. Five-gaited horses must perform two additional
s; namely, (a) a slow gait (either the running-walk, fox-trot, or step-
pace) and (b) the rack or single foot. In addition to performing the
s with perfection, both three- and five-gaited horses should possess de-
ble conformation, perfect manners, and superior style and animation.
awing by R. F. Johnson.)

CHAPTER XL

DETERMINING THE AGE AND HEIGHT OF HORSES

Establishing the age of horses through the appearance of the teeth is not new. Apparently this technique was known in ancient days. It is not surprising, therefore, to find that the old saying "Do not look a gift horse in the mouth" is attributed to Saint Jerome, a Father of the Latin Church and papal secretary in the fifth century, who used this expression in one of his commentaries.

Physical changes within the body are constant. As they affect the general outward appearance and disposition of the horse within certain limits, it is possible by mere general appearance to estimate the age of the animal. Changes in the teeth, however, afford a much more accurate method.

There is nothing mysterious about the determination of the age by the teeth. In horses up to five years of age, it is simply a matter of noting the number of permanent and milk teeth present. From six to twelve years, the number of cups or indentations in the incisor teeth are used; whereas the age of horses beyond twelve years may be estimated by studying the cross section and slant of the incisor teeth. It must be realized, however, that theoretical knowledge is not sufficient and that anyone who would become proficient must also have practical experience. The best way to learn how to recognize age is to examine the teeth in horses of known ages.

THE IMPORTANCE OF AGE

As the productive life of the horse is comparatively brief and the height of his usefulness is even more limited, the market value of the animal increases rather sharply with maturity and then decreases beyond eight years of age. On the other hand, for many purposes horses are quite useful up to twelve years of age or longer.

NUMBER AND TYPES OF TEETH

The mature male horse has a total of forty teeth; whereas the young animal, whether male or female, has twenty-four. These may be listed as shown in Table 74.

TABLE 74

NUMBER AND TYPES OF TEETH

ber of teeth ature animal	Number of teeth of young animal	Type of teeth
24	12	Molars or grinders.
12	12	Incisors or front teeth (the two central incisors are known as centrals or nippers; the next two—one on each side of the nippers—are called intermediates or middles; and the last—or outer pair—the corners).
4	None	Tushes or pointed teeth. These are located between the incisors and the molars in the male.

As the tushes are usually not present in the mare, the ma- female may be considered as having a total of thirty-six h rather than forty as in the male.

The good horseman is also aware of the difference between manent and temporary teeth. The temporary or milk teeth smaller, much whiter, and have a distinct neck at the junction he crown and fang, which is at the gum line. After their ption, the permanent teeth may be distinguished from the porary teeth by their greater size, darker color, a broader k showing no constriction, and greater width from side to .

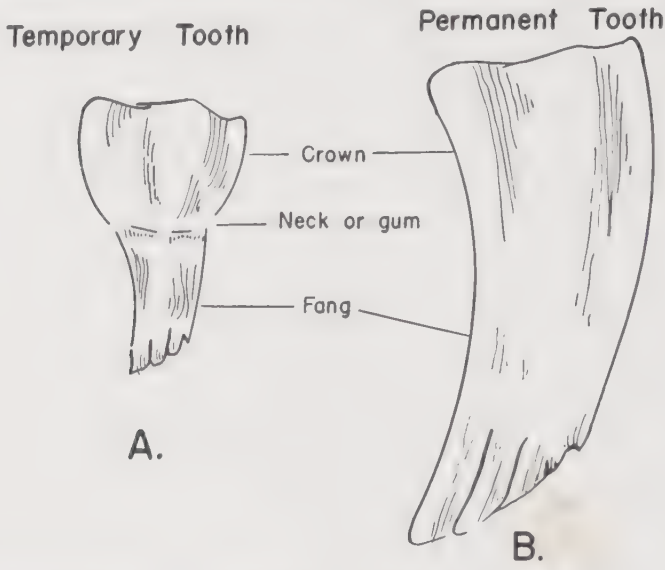
The permanent incisor teeth of young horses five to seven rs of age are elliptical or long from side to side; whereas en the animal becomes older, these teeth become triangular, h the apex of the triangle pointed upward. As the animal ances still more in age, the teeth become more slanting. In- ad of curving to approach a right angle with the jaws, they nt outward.

From five to twelve years of age the wearing surface of the s is the most reliable indication of age. At fairly regular in- vals, according to age, the cups disappear with wear.

RUCTURE OF THE TOOTH

The tooth consists of an outside cement and a second layer a very hard enamel followed by the dentine and a dark center own as the pulp. The enamel passes up over the surface of the th and extends inward, forming a pit. The inside and bottom the pit, which is blackened by feed, constitutes the "mark" or

"cup." As the rims of these cups disappear through wear, two distinct rings of enamel remain, one around the margin of the tooth and the other around the cup. With wear, the cups become



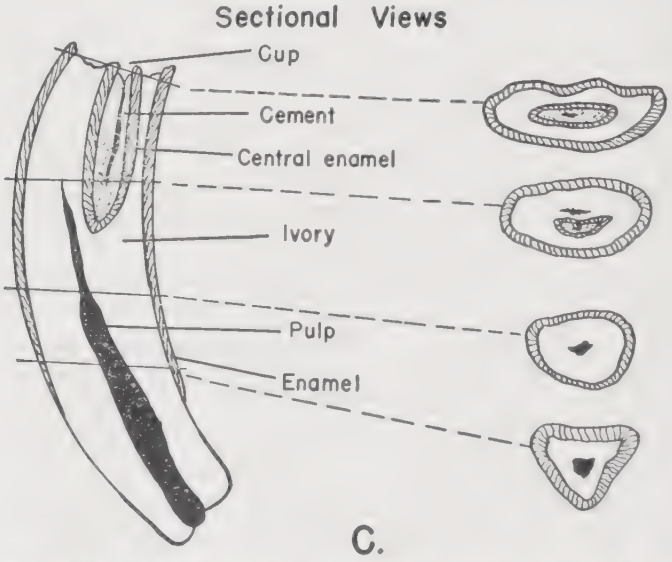


Fig. 378. The horse's tooth. A, temporary lower pincer tooth; B, permanent lower pincer tooth. Temporary or milk teeth are smaller and much whiter than permanent teeth, and constricted at the gum line (neck). C, longitudinal section of a permanent lower middle pincer tooth; and cross sections of permanent lower middle pincer teeth at different age levels. These drawings show why, with advancing age, the teeth of a horse (1) slant out toward the front, (2) change in wearing surface as noted in the cross sectional shape, (3) change in shape of cups and in the time of disappearance of the cups, and (4) change in the appearance and shape of the dental star. (Drawing by R. F. Johnson.)

aller—first more oval or rounding in shape, then triangular l more shallow, and they finally disappear completely. Further ar on the table or grinding surface of the tooth exposes the of the pulp canal or cavity in the center of the tooth. The posed tip of this canal, which appears between what is left of cup and the front of the tooth, is known as the "dental star." e gradual wearing and disappearance of the cups according to ather definite pattern in period of time enables the experienced rseman to judge the age of an animal with a fair degree of uracy up to twelve years.

A summary showing the changes in teeth according to usual e intervals is given in Table 75.

TABLE 75

A SUMMARY OF THE CHANGES OF THE TEETH OF HORSES

Age	Condition of teeth	
birth or before	First or central upper and lower incisors appear.	Appearance of temporary teeth
en days of age		
6 weeks of age	Second or intermediate upper and lower incisors appear.	
10 months	Third or corner upper and lower incisors appear.	
ear of age	Crowns of central incisors show wear.	Wear of temporary teeth
years of age	Intermediate incisors show wear.	
ears of age	All temporary incisors show wear.	
years of age	First or central incisors appear.	Appearance of permanent teeth
years of age	Second or intermediate incisors appear.	
years of age	Third or corner incisors appear.	
5 years of age male)	Canines appear.	
ears of age	Cups in all incisors.	Wear of permanent teeth
ears of age	Cups worn out of lower central incisors.	
ears of age	Cups also worn out of lower intermediate incisors.	
ears of age	Cups worn out of all lower incisors, and dental "star" appears on lower central and intermediate pairs.	
ears of age	Cups also worn out of upper central incisors, and dental "star" appears on upper central and intermediate pairs.	
years of age	Cups also worn out of upper intermediate incisors, and dental "star" is present on all incisors, both upper and lower.	
years of age	No cups. "Smooth mouthed."	
years of age	Cups worn out of all upper and lower incisors, and dental "star" approaches center of cups.	

After twelve years of age, even the most experienced horseman cannot accurately determine the age of an animal. It is known, however, that with more advanced age the teeth change from oval to triangular and that they project or slant forward more and more each year.

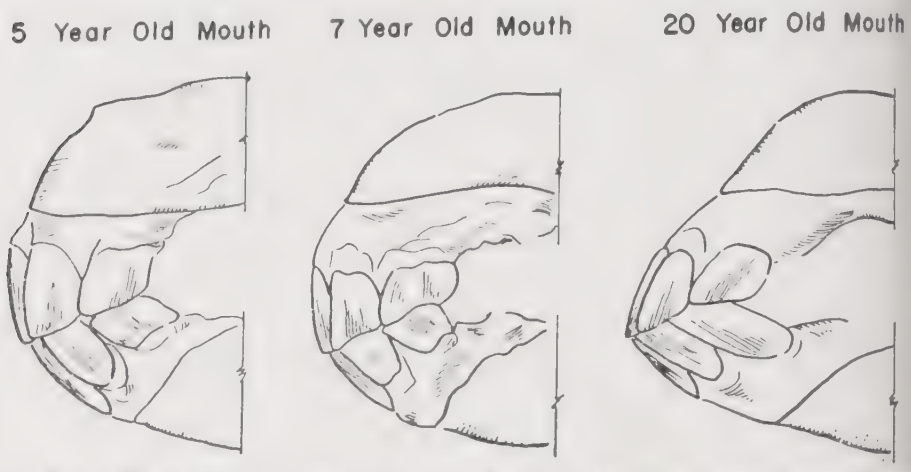


Fig. 379. Side view of 5-, 7-, and 20-year-old mouth. Note that as the horse advances in age the teeth change from nearly perpendicular to slanting sharply toward the front. (Drawing by R. F. Johnson.)

It must also be realized that the environment of the animal can very materially affect the wear on the teeth, often making it impossible to determine accurately the age of animals. For example, the teeth of horses raised in a dry, sandy area will show more than normal wear. Thus the five-year-old western horse may have a six- or even eight-year-old mouth. The unnatural wear resulting in the teeth of cribbers or animals with parrot mouth or undershot jaw also makes it difficult to estimate age.

TAMPERED OR "BISHOPED" TEETH

Occasionally, unscrupulous horsemen endeavor to make the amateur a victim of their "trade tricks," especially through tampering with the teeth. As very young horses increase in value to a certain stage, the milk teeth are sometimes pulled a few months before they would normally fall out. This hastens the appearance of the permanent teeth and makes the animal appear older.

"Bishoping" is the practice of artificially drilling, burning, or staining cups in the teeth of older horses in an attempt to make them sell as young horses. The experienced horseman can detect such deception because the ring of enamel that is always

sent around the natural cup cannot be reproduced. This makes practice more difficult than counterfeiting money. Moreover, slanting position and triangular shape of the teeth of an older mal cannot be changed. An experienced horseman should ays be called upon to make an examination if there is any picion that the teeth have been tampered with.

ASURING HORSES

The normal measurements pertinent to a horse are his height, (2) weight, (3) girth, and (4) bone.

ight

The height of a horse is determined by standing him squarely a level area and measuring the vertical distance from the hest point of his withers to the ground. The unit of measure- nt used in expressing height is the "hand," each hand being nches. Thus a horse measuring 60 inches is said to be 15 nds high. Animals standing less than 14-2 are classed as ponies.

Instead of actually measuring by calipers or tape, the experi- ced horseman deftly estimates the height of a horse in relation

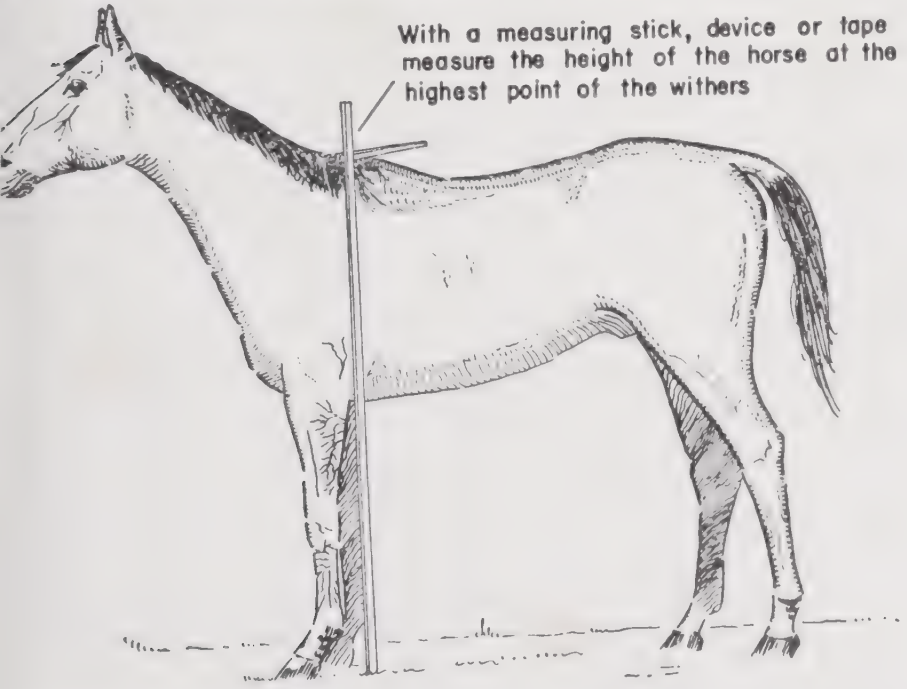


Fig. 380. The height of a horse is measured from the highest point of e withers to the ground. The experienced horseman deftly estimates the ight of a horse in relation to his own stature, and does not use any easuring device. (Drawing by R. F. Johnson.)

to his own stature. Thus, by knowing the exact height from the ground to the level of his eyes, the horseman can stand opposite the front limbs of the horse, look to the highest point of the withers, and estimate the height very quickly and accurately.

Weight

The weight of a horse is best determined by placing the animal on a properly balanced scale. The weight is recorded in pounds.

Girth

The girth is a measure of the circumference of the chest below a point back of the withers and in front of the back. A large girth is desired because it indicates ample space for such vital organs as the heart and lungs.

Bone

The size of the bone is usually determined by placing a tape measure around the cannon bone half way between the knee and fetlock joints. The reading is recorded in inches.

CHAPTER XLI

UNSOUNDNESSES AND STABLE VICES

After one has acquired a thorough knowledge of the normal ucture and function of the horse, the recognition of abnormal ditions is simplified.

STINCTION BETWEEN BLEMISHES D UNSOUNDNESSES

Technically speaking, any abnormal deviation in structure function constitutes an unsoundness. From a practical standnt, however, a differentiation is made between those abnorlities that do and those that do not affect the serviceability of orse. Thus the following definitions usually apply:

1. **Blemishes** include those abnormalities that do not affect serviceability of the horse. Such unsightly things as wire s, rope burns, nail punctures, shoe boils, capped hocks, etc. are nerally placed under this category.

2. **Unsoundnesses** include those more serious abnormalities t affect the serviceability of the horse.

USES OF UNSOUNDNESSES

Unsoundnesses may be caused by any one or various comnations of the following:

1. An inherent or predisposing weakness.
2. Subjecting the horse to strain and stress far beyond the pability of even the best structure and tissue.
3. Accident and injury.
4. Nutritional deficiencies, particularly minerals.

Unsoundnesses that can be definitely traced to the latter ree causes should not be considered as hereditary. Unless one very positive, however, serious unsoundnesses should always regarded with suspicion in the breeding animal. Probably no soundness is actually inherited, but the fact that individuals ay inherit a predisposition to unsoundness through faulty conrmation cannot be questioned.

OCATION OF COMMON BLEMISHES ND UNSOUNDNESSES

Figure 381 and the following outline give the body location the common blemishes and unsoundnesses. As would be susected, the great preponderance of troubles affect the limbs.

I. Head:
1. Blindness
2. Moon blindness (periodic opthalmia)
3. Parrot mouth and undershot jaw
4. Poll-evil

II. Withers and shoulders:
1. Fistulous withers
2. Sweeney

III. Front limbs:
1. Bowed tendons
2. Calf-kneed
3. Cocked ankles
4. Knee-sprung
5. Ring bone
6. Shoe boil
7. Splints
8. Wind-puffs

Front Feet:
9. Contracted feet
10. Corns
11. Founder or laminitis
12. Navicular disease
13. Quarter-crack or sand-crack
14. Quittor
15. Scratches or grease heel
16. Side bones
17. Thrush

IV. Rear limbs:
1. Cocked ankles
2. Ring bone
3. Stifled
4. Stringhalt
5. Wind-puffs

Hocks:
6. Blood spavin
7. Bog spavin
8. Bone spavin or jack
9. Capped hock
10. Curb
11. Thoroughpin

Hind Feet:
12. Contracted feet
13. Corn
14. Founder or laminitis
15. Quarter-crack or sand-crack
16. Quittor
17. Scratches or grease heel
18. Thrush

V. General:
1. Heaves
2. Hernia or rupture
3. Roaring
4. Thick wind

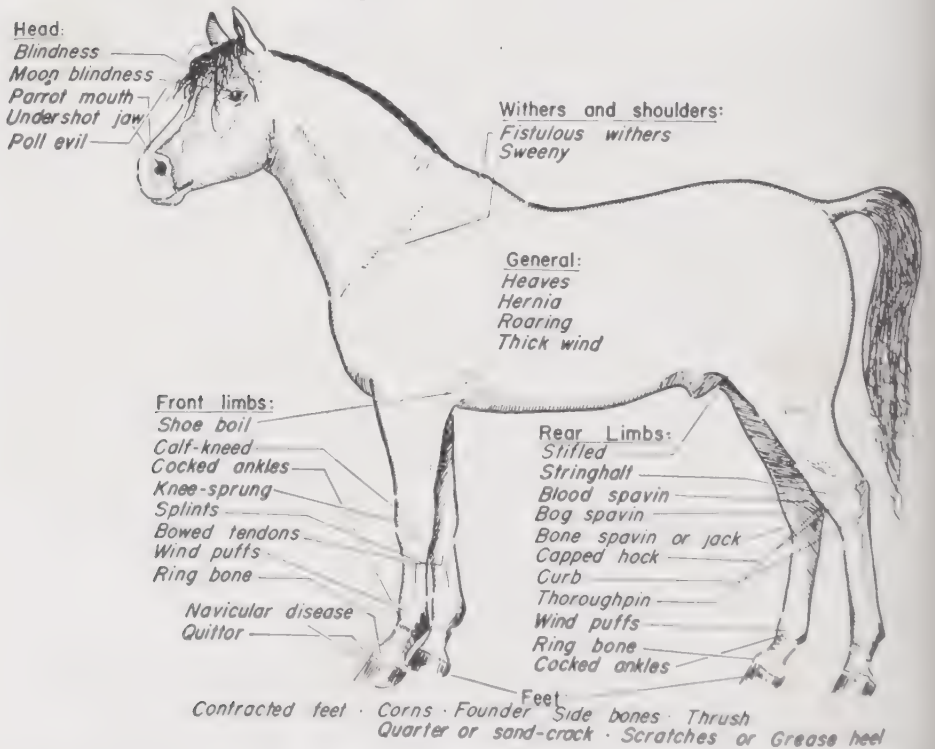


Fig. 381. Location of points of common unsoundness in horses. (Drawing by R. F. Johnson.)

SCRIPTION AND TREATMENT OF COMMON EMISHES AND UNSOUNDNESSES

The following brief description and treatment pertains to common blemishes and unsoundnesses of different body as.

soundnesses of the head

The most serious unsoundnesses of the head are those that ect the sight of the animal, namely, blindness and moon blinds. In addition, poll-evil is very serious, and the parrot mouthed undershot jaw conditions are most undesirable.

INDNESS:

Partial or complete loss of vision is known as blindness. her or both eyes may be affected. A blind horse usually has y erect ears and a hesitant gait. Frequently blindness also be detected by the discoloration of the eye. Further and e certain verification can be obtained by moving the hand in e proximity to the eye.

ON BLINDNESS (OR PERIODIC OPHTHALMIA):

Moon Blindness (or periodic ophthalmia) is a cloudy or ined condition of the eye which disappears and returns in les that are often completed in about a month. Because many ple formerly believed the cycle to be related to changes of the on, it was given the name of "moon blindness." Experiments iated at the Front Royal Remount Depot, beginning in 1943, wed that periodic ophthalmia is a nutritional deficiency dise caused by a deficiency of riboflavin, a B vitamin. Riboflavin is ndant in green forages of all kinds—green hays and green tures—and the condition may be prevented by supplying ple quantities of these feeds.[1]

RROT MOUTH AND UNDERSHOT JAW:

Both parrot mouth and undershot jaw are hereditary imperions in the way in which the teeth come together. In parrot uth, the lower jaw is shorter than the upper jaw. The reverse dition is known as undershot jaw.

LL EVIL:

This is an inflamed condition in the region of the poll (the a on top of the neck and immediately behind the ears). It is

[1] In the Front Royal Experiments, when crystalline riboflavin was added he ration at the rate of 40 milligrams per horse per day, no new cases eriodic opthalmia developed.

usually caused by bruising the top of the head. The swelling, which may be on one or both sides, usually contains pus or a straw-colored fluid. At first the affected area is hot and painful, but later the acute symptoms of inflammation subside. Treatment, which should be handled by a veterinarian, consists of establishing proper drainage and removing all dead tissue. In addition to surgery, some veterinarians claim that recovery is hastened by injections of a specially prepared bacterin. Poll evil is slow to yield to treatment, and it may break out again after it is thought to be cured.

Unsoundnesses of the withers and shoulders

Though less frequent in occurrence than the unsoundnesses of the feet, the conditions of the shoulders known as fistulous withers and sweeney are very injurious to animals which are affected.

FISTULOUS WITHERS:

Fistulous withers is an inflamed condition in the region of the withers, commonly thought to be caused by bruising. Fistula



Fig. 382. An average case of shoulder fistula on a farm draft horse. This is an inflamed condition caused by bruising. (Courtesy, J. W. McManigal, Agricultural Photographs, Horton, Kansas.)

l poll evil are very similar except for location. As in poll evil refore, treatment for fistulous withers, which should be ndled by a veterinarian, consists of establishing proper drain- e and removing all dead tissue. Caustic applications to destroy diseased tissues should be used only on the advice of a mpetent veterinarian.

EENEY:

A depression in the shoulder due to atrophied muscles is own as sweeney. Sweeney is caused by nerve injury. No known atment will restore the nerve, but it is possible to fill in the pression by injecting irritants into the affected area.

soundnesses of the front limbs

Although they are confined to a relatively small proportion the anatomy of the horse, there appears to be hardly any it to the number of unsoundnesses that may affect the front bs. The major unsoundnesses of this type will be discussed efly.

WED TENDONS:

Enlarged tendons behind the cannon bones, in both the front l hind legs, are called bowed tendons. This condition is often ught about by severe strains, such as heavy training or rac- . When bowed tendons are pronounced, more or less swelling, eness, and lameness are present. Treatment consists of blister- or firing. The object of blistering and firing is to convert a onic into an acute inflammation. This hastens nature's cesses by bringing more blood to the part, thus inducing a arative process which renders the animal suitable for work ner than would otherwise be the case.

Blisters consist of such irritating substances as Spanish fly l iodide of mercury (one common preparation consists of 15 ts Spanish fly, 8 parts iodide of mercury, and 120 parts of d). Before applying a blister, the hair should be closely clipped m the affected area, the scurf brushed from the skin, and the mal tied so that it cannot rub lick, or bite the treated area. e blistering agent is then applied by rubbing it into the pores the skin with the palm of the hand. Three days later the stered area should be bathed with warm water and soap, dried, l treated with sweet oil or vaseline to prevent cracking of the n. Firing, which is used for about the same purposes as stering, consists of the application of a hot iron or the use of rmocautery to the affected area.

CALF-KNEED:

Standing with knees too far back, directly opposite to the buck-kneed or knee-sprung, is called calf-kneed.

COCKED ANKLES:

Cocked ankles, a condition usually limited to the hindfeet, is found in horses that stand bent forward on the fetlocks in a cocked position. This condition can be corrected by proper trimming, allowing the toes to grow out while keeping the heels trimmed.

KNEE SPRUNG:

A condition of being over in the knees, or with the knees protruding too far forward, is known as knee-sprung or buck-kneed.

RING BONE:

Ring bone is a bony growth on the pastern bone of the forefoot, although occasionally the hind foot is affected. The condition usually causes a lameness, accompanied by a stiff ankle. This condition generally follows severe straining, blows, sprains, or improper shoeing. Treatment consists of the application of cold-



Fig. 383. Ringbone on the right foot. This is a bony growth on the pastern bone of the forefoot, although occasionally the hind foot is affected. (Courtesy, Major C. B. Team, U.S.D.A.)

ter bandages for temporary relief. For more permanent relief, erinarians sometimes resort to blistering, firing, or severing the nerve leading to the area. The condition is thought to be reditary.

OE BOIL (OR CAPPED ELBOW):

Shoe boil is a soft, flabby swelling caused by an irritation at point of the elbow, hence the common name "capped elbow." e two most common causes of this unsoundness are injury m the heel calk of the shoe and injury from contact with the or. Affected animals may or may not go lame, depending upon degree of inflammation and the size of the swelling. If dis-ered while yet small, shoe boil may be successfully treated by ly applications of tincture of iodine and the use of the shoe l boot or roll. The latter is strapped about the pastern in such anner as to keep the heel from pressing upon the elbow while horse is in a recumbent position. For treatment of large oe boils surgery by a veterinarian may be necessary, but such atment is not always successful. Some horsemen report good ults from the use of ligature which is passed around the neck the swelling and tightened each day until circulation is stopped l the whole mass sloughs off.



Fig. 384. Splints on left front leg. Splints are abnormal bony growths nd on the inside of the cannon just below the knee. (Courtesy, Major B. Team, U.S.D.A.)

SPLINTS:

Splints are abnormal bony growths found on the inside of the cannon just below the knee. They are not often found on the hind legs. Splints may enlarge and interfere with a ligament and cause irritation and lameness. Their presence detracts from the appearance of the animal, even when there is no lameness. When found on young horses, they often disappear. Point firing, blistering agents, and tincture of iodine have each been employed with variable success in treating splints.

WIND PUFFS (OR WINDGALL):

Windgalls or "puffs" are an enlargement of the fluid sac (bursa) located immediately above the pastern joints on the fore and rear legs. They are usually the result of too fast or hard road work, especially on hard surfaces. Treatment consists of applying cold packs followed by linaments or sharp blistering agents. Firing or draining by a veterinarian may be in order, but experienced horsemen report that in many cases no permanent benefit results from such treatment.

CONTRACTED FEET:

This condition, known as contracted, most often occurs in the forefeet and is characterized by a drawing in or contracting at the heels. A tendency toward contracted feet may be inherited, but improper shoeing usually aggravates the condition. Paring, removal of shoes, or use of special shoes constitutes the best treatment.

CORNS:

A bruise to the soft tissue underlying the horny sole of the foot—which manifests itself in a reddish discoloration of the sole immediately below the affected area—is known as a corn. Fast work on hard and rough roads, flat soles, weakened bars, and poor shoeing may cause corns. Paring, special shoeing, poulticing, sanitation, and rest constitute the best treatment.

FOUNDER (OR LAMINITIS):

Founder (or laminitis) is a serious ailment of the fleshy laminae. Founder may be caused by (1) overeating, (2) overwork, (3) by giving animals too much cold water when they are hot, or (4) by inflammation of the uterus following foaling. All feet may be affected, but the front feet are more susceptible. Prompt treatment by a competent veterinarian will usually alleviate permanent injury. Until the veterinarian arrives, the

rse may be given great relief by applying cold applications to e feet. This may be accomplished by wrapping the feet with rlap bags saturated with cold water or by standing the horse in foot bath. If the condition is neglected, chronic laminitis will velop and will cause dropping of the hoof soles and a turning up the toe walls.

AVICULAR DISEASE:

Navicular disease is an inflammation of the small navicular ne and bursa of the front foot. It is often impossible to deter-ne the exact cause of the disease. Afflicted animals go lame; ve a short, stubby stride; and usually "point" the affected ot when standing. Few animals completely recover from the ease. Treatment consists of special shoeing. In cases of per-tent and severe lameness, unnerving may be performed by a terinarian, who can destroy sensation in the foot.

JARTER-CRACK (OR SAND-CRACK):

A vertical split in the horny wall of the inside of the hoof the region of the quarter), which extends from the coronet or of head downward, is known as quarter-crack or sand-crack. nen the crack is on the fore part of the toe, it is termed toe ack. This condition usually results from allowing the hoof to come too dry and brittle or from improper shoeing. Special oeing or clamping together of the cracks are the usual eatments.

UITTOR:

Quittor is a deep-seated running sore at the coronet or hoof ad. It causes severe lameness. The infection may arise from a ncture wound, corns, and sand-cracks; or it may be carried in e blood stream. Quittor is usually confined to the forefeet, but sometimes occurs in the hind feet. Drainage and antiseptics ay relieve the condition, although surgery by a veterinarian ay be necessary.

CRATCHES (OR GREASE HEEL):

Scratches or grease heel is a mange-like inflammation of the sterior surfaces of the fetlocks, most frequently confined to e hind legs. Treatment consists of placing the affected animal clean quarters, clipping closely all hair on the affected areas, eaning with mild soap and water, and applying astringent, tiseptic substances at regular intervals.



Fig. 385. Quittor on right hind foot. This is a deep-seated running sore at the coronet or hoof head. It causes severe lameness. (Courtesy, Major C. B. Team, U.S.D.A.)

SIDE-BONES:

Side-bones are ossified lateral cartilages immediately above and toward the rear quarter of the hoof head. They occur most commonly in the forefeet. Lameness may or may not be present. This is perhaps the most common unsoundness of the feet of horses.

Side-bones may be partially or entirely of genetic origin; or the condition may result from running or working horses on pavement or other hard surface. Side-bones may also develop following sprains, cracks, quittor, or other injuries. Treatments vary and are not always successful. Temporary relief from fever and soreness can usually be obtained through the application of

d-water bandages. Veterinarians sometimes apply blistering ents, fire, or sever the nerve leading to the area.

IRUSH:

Thrush is a disease of the frog. It is most commonly found the hind feet and is caused by unsanitary conditions in the imal's stall. Most cases will respond to sanitation and the use an antiseptic.

nsoundnesses of rear limbs

Unsoundnesses of the rear limbs may rather seriously im- ir the efficiency and usefulness of the horse, for the hind legs e the animal's source of propulsion in forward movement.

TIFLED:

A horse is said to be stifled when the patella of the stifle nt has been displaced. Occasionally, the patella can be placed ck in normal position, but more often the affected horse is ndered useless.

TRINGHALT:

Stringhalt is characterized by excessive flexing of the hind gs. It is most easily detected when backing a horse. The con- tion may be cured or greatly relieved by a surgical operation the lateral extensor tendon. An incision is made over the ten- n on the outside of the leg just below the hock, and about two ches of the tendon is removed.

LOOD SPAVIN:

Blood spavin is a varicose vein enlargement which appears the inside of the hock but immediately above the location of g spavin. No successful treatment for blood spavin is known.

OG SPAVIN:

Bog spavin is a filling of the natural depression on the inside d front of the hock. A bog spavin is much larger than a blood avin. Treatment consists of applying a special bog-spavin truss of applying tincture of iodine. Blistering or firing is seldom ccessful.

ONE SPAVIN (OR JACK SPAVIN):

Bone spavin (or jack spavin) is a bony enlargement that pears on the inside and front of the hock at the point where e base of the hock tapers into the cannon part of the leg. It one of the most destructive conditions affecting the usefulness a horse. The lameness is most evident when the animal is used



Fig. 386. Bog spavin on right hock (No. 1) and bone spavin on left hock (No. 2). Bog spavin is a filling of the natural depression on the inside and front of the hock. Bone spavin is a bony enlargement that appears on the inside and the front of the hock at the point where the base of the hock tapers into the cannon part of the leg. (Courtesy, Major C. B. Team, U.S.D.A.)

following rest. A hereditary weakness—together with such things as bruises, strains, and sprains—appears to cause bone spavin. Rest seems to be the most important treatment. Counter-irritants, iodine, linaments, and blistering agents have all been used with varying degrees of success. Surgery or firing by a qualified veterinarian may be in order.

CAPPED HOCK:

Capped hock is an enlargement at the point of the hock; it is usually caused by bruising. Daily painting of the enlargement with tincture of iodine may help to diminish it. Though it may be unsightly, capped hock need not be considered serious unless it interferes with the work of the horse.

CURB:

Curb is the name given to the condition in which there is a fullness at the rear of the leg and below the point of the hock.

s fullness is due to enlargement of the ligament or tendon. e condition is caused by anything that brings about a thicken- in the ligament, tendon, or skin of this region so as to cause eviation in the straight line that normally extends from the nt of the hock to the fetlock. Firing and blistering are the al treatments.

OROUGHPIN:

Thoroughpin is a puffy condition in the web of the hock. It be determined by movement of the puff, when pressed, to opposite side of the leg. Treatment consists of applying pres- e and massaging, but these may not always be successful.

neral unsoundnesses of the horse

Hernia and certain abnormal respiratory conditions are ssed as general unsoundnesses. These unsoundnesses greatly er the usefulnesss and value of affected animals.

AVES:

Heaves is a difficulty in forcing air out of the lungs. It is aracterized by a jerking of the flanks (double-flank action) l coughing after drinking cold water. There is no satisfactory atment, although affected animals are less bothered if turned pasture, if used only at light work, or if the hay is sprinkled htly with water at the time of feeding.

ERNIA (OR RUPTURE):

Hernia (or rupture) refers to the protrusion of any internal gan through the wall of its containing cavity, but it usually ans the passage of a portion of the intestine through an open- g in the abdominal muscle. Umbilical, scrotal, and inguinal rnias are fairly common in young foals.

OARING:

An animal that whistles or wheezes when respiration is eeded up with exercise is said to be a "roarer." Within recent ars a surgical operation has been perfected which when operly performed is successful in about 70 per cent of the cases treated.

HICK WIND:

Difficulty in breathing is known as thick wind.

ICES

Vices are difficult to suspect for they are often present in e most handsome and lovable creature. Some vices are vicious

and dangerous to man and other animals; others inflict punishment upon the offender himself; and still others merely use energy wastefully. Regardless of the type of vice, it is undesirable and to be avoided. In general, vices may be divided into two classifications: stable vices and other vices.

Common stable vices

As the name would indicate, stable vices are those which are observed in confinement. Perhaps many of these have arisen because of the unnaturalness of stabled conditions.

CRIBBER:

A horse that has the vice of biting or setting the teeth against some object, such as the manger, while sucking air is known as a cribber. This causes a bloated appearance and hard keeping; and such horses are more subject to colic. The common remedy for a "cribber" is a strap buckled around the neck. A surgical operation to relieve cribbing has been developed and used with some success.

HALTER PULLING:

Halter pulling refers to a pulling back on the halter rope when tied in the stable.

KICKING:

Occasionally, unusual excitement or injury will cause the so-called "gentle horse" to kick. However, a true stable kicker appears to have no other excuse than the satisfaction of striking something or somebody with his hind feet.

TAIL RUBBING:

Persistent rubbing of the tail against the side of the stall or other objects is objectionable. The presence of parasites may cause animals to acquire this vice. Installation of a tail board or electric wire may be necessary in breaking animals of this habit.

WEAVING:

A rhythmical swaying back and forth while standing in the stall is called weaving.

BOLTING:

Bolting is the name given to those ravenous horses that eat too fast. This condition may be controlled by adding chopped hay to the grain ration or by placing some large, round stones as big or bigger than baseballs in the feed box.

her vices

Other vices that are often difficult to cope with and which tract from the value of the animal are: balking, backing, rear-g, shying, striking with the front feet, a tendency to run away, d objection to harnessing, saddling, and grooming. Many of ese vices originate with incompetent handling; nevertheless, ey may be difficult to cope with or to correct. This is especially ue in older animals, thus lending credence to the statement ou can't teach an old horse new tricks."

CHAPTER XLII

THE HORSE IN ACTION

In the wild state, the horse executed four natural gaits—the walk, trot, pace, and gallop or run. Under domestication, these gaits have been variously modified, and additions have been made through (1) type, (2) breeding and selection, and (3) schooling.

RELATION OF TYPE TO ACTION

Regardless of the use to which horses are put, certain points in conformation are stressed—for example, a shapely, clean-cut head with a large, clear eye; a strong, heavily-muscled top line; heavy muscling in the forearm and gaskin; and correct set to the feet and legs. Yet, certain differences in conformation better adapt the animal for use in specific types of work—as draft animals, gaited saddle horses, running horses, light or heavy harness horses, or hunters, etc. These differences are often as marked as those in the build of the ten-second track man and the champion wrestler. The thickness, massiveness, and low-station of the draft horse are points of conformation that adapt him to power at the walk; whereas the angular form, relatively long legs, well-muscled hind quarters, and close-to-the-ground action of the Thoroughbred constitute form conducive to great speed at the run. But many less exaggerated differences exist. Thus, a horse with straight shoulders and short, straight pasterns is almost certain to be short and choppy in his action, and a very wide-fronted conformation often predisposes paddling.

RELATION OF BREEDING AND SELECTION TO ACTION

The relation of breeding and selection to action becomes especially obvious in a group of weanlings of mixed breeding. Upon starting across a field, some amble off in a rhythmic running-walk, nodding their heads as they go; others travel high enough to clear the tops of the daisies; still others break away in an easy gallop. Each of these three types of action is executed with equal ease and naturalness. The first weanlings described are Tennessee Walking Horses, the second are Hackneys, and

third are Thoroughbreds. In each of these breeds, the distinc- way of going has been accomplished through years of breed- and selection.

LATION OF SCHOOLING TO ACTION

If the offspring of Man-O-War and six of the fastest mares grace the tracks during the past two decades had merely rked on a laundry truck until six years old and if they then ldenly—without training or other preparation—had been ced upon a race track, the immediate results would have been appointing. Their natural aptitude in conformation and breed- would not have been enough. Schooling and training would l have been necessary in order to bring out their inherent lity. No horse—whether he be used for saddle, race, or other rposes—reaches a high degree of proficiency without an ıcation.

On the other hand, it must be emphasized that it is equally appointing to spend time and money in educating a colt for rposes to which he is not adapted. It is difficult, for example, train a Hackney as a five-gaited park hack, and it is equally satisfactory to school a born Standardbred to the high action the heavy harness horse.

It should also be pointed out that horses, like people, are ely to revert to an untrained status if placed under improper vironment—despite type, breeding, and early schooling. Thus inexperienced rider may, through ignorance, allow the most autifully trained five-gaited park hack to revert to a very linary mount. Proper and frequent handling is necessary if a rse of this training is to retain the five distinct gaits which e executed in a proud and collected manner. For this reason, e less experienced rider often rightfully prefers and will pay ore for a three-gaited saddle horse than for a five-gaited one.

HE GAITS

A gait is a particular way of going, either natural or ac- ired, which is characterized by a distinctive rhythmic move- ent of the feet and legs. In proper show-ring procedure, horses e brought back to a walk each time before being called upon to ecute a different gait. Sometimes an exception is made in five- ited classes, where the rack may be executed from the slow it.

The Walk

The walk is a natural, slow, flat-footed, four-beat gait. It should be springy, regular, and true. On the draft horse, in which class of animals it constitutes the most important gait, the walk should be executed as a powerful stride; whereas the American Saddle Horse displays what is known as a "proud walk," which calls for high action and attractiveness in contrast to power.

The Trot

The trot is a natural, rapid, two-beat, diagonal gait in which the diagonal fore and hind feet strike the ground simultaneously. This gait varies considerably according to breed and training. The trot of the Standardbred is characterized by the length and rapidity of the individual strides; whereas the trot of the Hackney shows extreme flexion of the knees and hocks that produces a very high-stepping show gait.

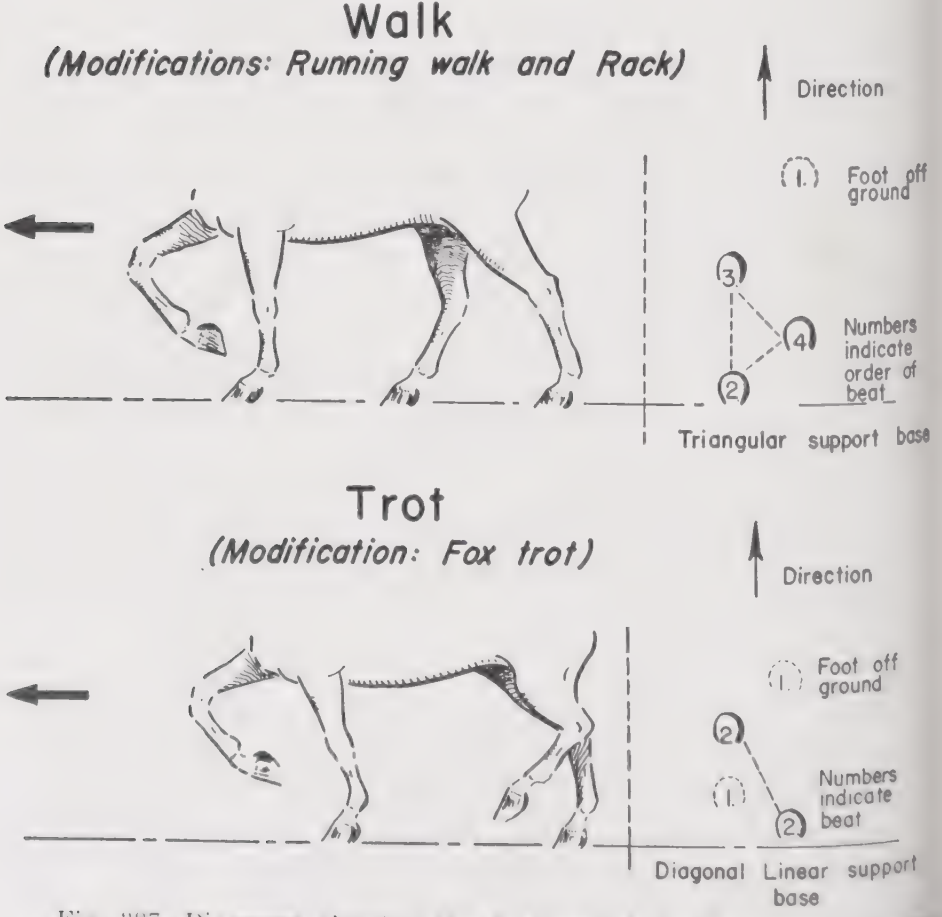
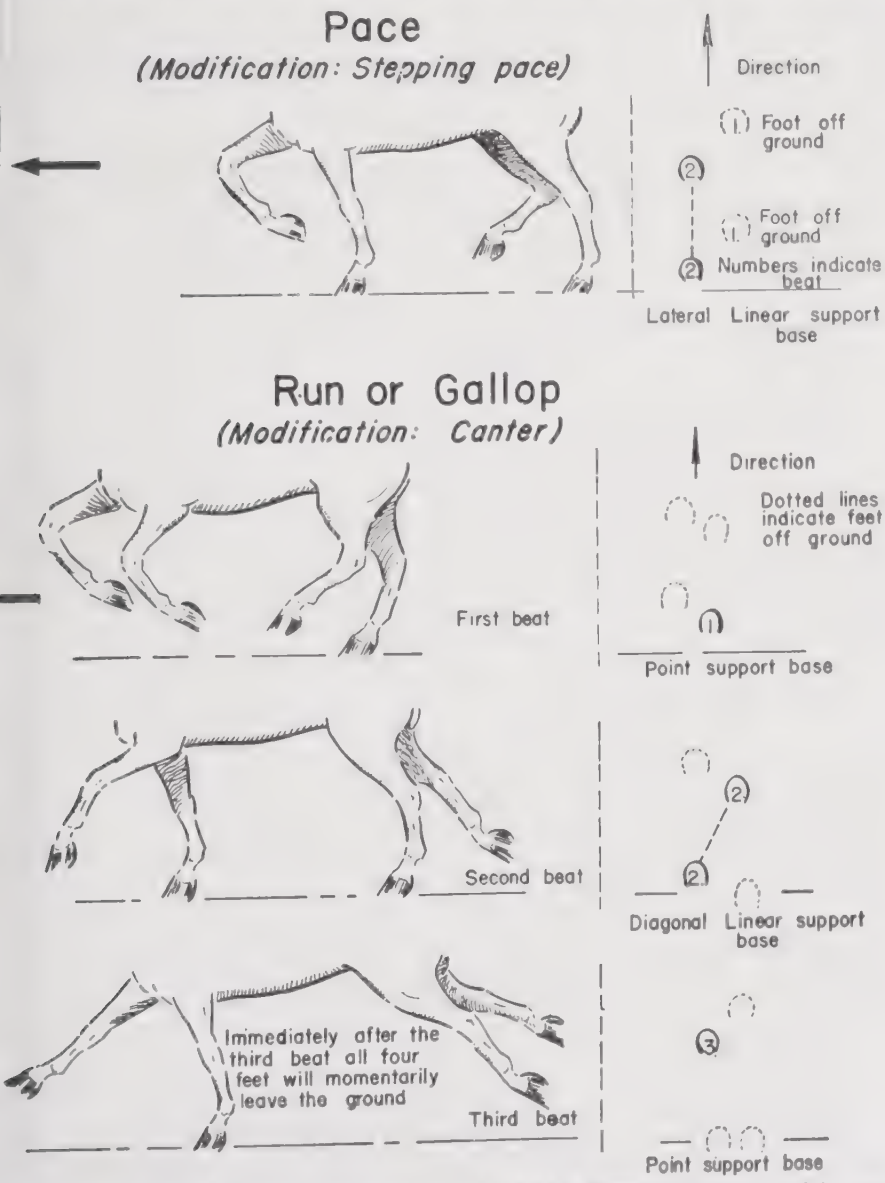


Fig. 387. Diagrams showing the features of the four natural gaits: (1) the walk, (2) the trot, (3) the pace, and (4) the run or gallop (three

Run or Gallop

The run or gallop is a fast, three-beat gait in which two onal legs are paired; the single beat falls between the suc- ive beats of the other two unpaired legs. The two unpaired that act independently—the fore with which the horse leads its diagonal hind—naturally bear more weight and are sub- to more fatigue than are the paired legs that act jointly. In euting the gallop, the propulsion is chiefly in the hind quar-



ges of the gallop). Note the movement of the feet and legs (left), and support base and beat of the feet (right). (Drawing by R. F. Johnson.)

ters, although the forequarters sustain a tremendous jar with each leap. The gallop is the fast natural gait of both the wild horse and the Thoroughbred race horse.

The Canter

The canter is a slow, restrained gallop or run. Like the gallop, the canter imposes a special wear on the leading forefoot and its diagonal hindfoot. It is important, therefore, that the lead should be changed frequently; and in a well-trained horse, this shift is easily made at the will of the rider. In the show ring, the lead should be toward the inside of the ring. It is changed by reversing the direction of travel (when the ring-master calls for, "reverse—and canter.")

It is a common saying among saddle horse enthusiasts that "a horse should canter all day in the shade of an apple tree." This is but another way of emphasizing that this gait should be executed in such a slow, collected manner that the animal may perform in a relatively small circle.

The Pace

The pace is a fast, two-beat gait in which the lateral fore and hind feet strike the ground simultaneously. It is faster than the trot but not as fast as the run or gallop. The pace was a popular gait in the early history of England, but it lost in favor soon after the development of the Thoroughbred. The pace allows for a "quick get-away" with a burst of speed, but it produces an objectionable side or rolling type of motion. The pace is not suited to travel in mud or snow, as a smooth, hard footing and easy draft are necessary for its best execution.

The Stepping Pace (or Slow Pace)

The stepping pace or slow pace is a modified pace in which the objectionable side or rolling motion is eliminated because the two feet on each side do not move exactly together. In the stepping pace, the hind foot touches the ground slightly ahead of the front foot on the same side, and each foot strikes the ground separately.

The Fox Trot

The fox trot is a slow, short, broken type of trot in which the head usually nods. In executing the fox trot, the horse brings each hind foot to the ground an instant before the diagonal forefoot. This gait is accepted as a slow gait, but it is not as popular as the stepping pace.

Running Walk

The running walk is a slow, four-beat gait, intermediate ween the walk and rack. The hind foot oversteps the front from a few to as many as eighteen inches, giving the motion iding effect. It is characterized by a bobbing or nodding of head, a flopping of the ears, and a snapping of the teeth in thm with the movement of the legs. The running walk is easy oth horse and rider. It is the all-day business gait of the th and is executed at a speed of six to eight miles per hour. s is a necessary gait in Plantation Walking Horses.

Rack or Single-Foot

The rack or single-foot is a fast, flashy, unnatural, four-beat in which each foot meets the ground separately at equal rvals; hence it was originally known as the "single-foot," a ignation now discarded. The rack is easy on the rider but st distressing to the horse. However, it is without doubt the st popular gait in the American show ring. On the tanbark, at speed at the rack is requested by giving the command to ck on."

Traverse or Side Step

The traverse or side step is simply a lateral movement of animal to the right or left as desired, without moving forward backward. This trick will often assist in (1) lining up horses the show ring, (2) opening and closing gates, and (3) taking ition in a mounted drill or a posse.

MMON DEFECTS IN WAY OF GOING

The feet of an animal should move straight ahead and paral- to a center line drawn in the direction of travel. Any deviations m this way of going constitute defects.

oss-Firing

Cross-firing, a defect in the way of going, is generally con- ed to pacers and consists of a "scuffing" on the inside of the gonal fore and hind feet.

velling

Dwelling, most noticeable in trick-trained horses, consists of noticeable pause in the flight of the foot, as though the stride re completed before the foot reaches the ground.

Forging

The striking of the forefoot by the toe of the hind foot is known as forging.

Interfering

The striking of the fetlock or cannon by the opposite foot that is in motion is known as interfering. This condition is predisposed in horses with base-narrow, toe-wide, or splay-footed standing positions.

Lameness

Lameness is a defect that can be detected when the affected foot is favored when standing. In action, the load on the ailing foot is eased, and there is characteristic "bobbing" of the head of the horse as the affected foot strikes the ground.

Paddling

Throwing the front feet outward as they are picked up is known as paddling. This condition is predisposed in horses with toe-narrow or pigeon-toed standing positions.

Pointing

Perceptible extension of the stride with little flexion is called pointing. This condition is likely to occur in the Thoroughbred and Standardbred breeds—animals bred and trained for great speed with a long stride.

Pounding

Pounding is a condition in which there is a heavy contact with the ground in contrast to the desired light, springy movement.

Rolling

Excessive lateral shoulder motion, characteristic of horses with protruding shoulders, is known as rolling.

Scalping

Scalping is that condition in which the hairline at the top of the hind foot hits the toe of the forefoot as it breaks over.

Speedy Cutting

Speedy cutting is a condition in which the inside of the diagonal fore and the hind pastern make contact. It is sometimes seen in fast trotting horses.

ringhalt

Stringhalt is characterized by excessive flexing of the hind gs. It is most easily detected when backing a horse.

appy

A short, quick, choppy stride is known as "trappy." This ndition is predisposed in horses with short, straight pasterns d straight shoulders.

inding or Rope-Walking

A twisting of the striding leg around in front of the support-g leg so as to make contact in the manner of a "rope-walking" tist is known as winding or rope-walking. This condition most ten occurs in horses with very wide fronts.

inging

Winging is an exaggerated paddling, particularly noticeable high-going horses.

CHAPTER XLIII

BREEDING HORSES

Although United States horse and mule numbers have declined very sharply during the past two decades, replacement animals will continue to be bred so long as equines retain their advantages for (1) performing certain types of draft work, (2) serving the livestock industry of the West, and (3) providing recreation and sport. It is important, therefore, that both the student and the progressive animal husbandman be familiar with the breeding of horses.

NORMAL BREEDING HABITS OF MARES

Perhaps at the outset it should be emphasized that strictly normal breeding habits of the horse do not exist under domestication. In the wild state, each band of thirty to forty mares was headed by a stallion leader who sired all of the colts in that band. With plenty of outdoor exercise on natural footing, superior nutrition derived from plants grown on unleached soils, regular production beginning at an early age, little possibility of disease or infection, and frequent services during the heat period, 90 per cent or higher foaling rates were commonplace. Under domestication, the average conception rate is less than 50 per cent, and only the occasional establishment exceeds 60 per cent. The good horsemen in Kentucky seldom get less than two-thirds of their mares in foal each year. Thus the low fertility usually encountered under domestication must be caused to a large extent by the relatively artificial conditions under which horses are mated.

Age of Puberty

Mares generally start coming in heat when 15 to 24 months of age.

Age To Breed Mares

Only exceptionally well-grown fillies should be bred as late two-year-olds, so as to foal at three years of age. Under a system of early breeding, the fillies must be fed exceptionally well in order to provide growth for their own immature bodies as well as for the developing fetus. Furthermore, they usually should

t be bred in the following year. Generally speaking, it is best breed the mare as a three-year-old so that she will foal when ır. Not only will the three-year-old be better grown, but there ll not be the handicap of training her while she is heavy in foal.

If they are properly cared for, it is not uncommon for brood ares to produce regularly up to fourteen to sixteen years of e; and, of course, in the more exceptional cases they may pro-ce up to twenty-five years of age.

In selecting a brood mare, it is usually advisable either to tain a young three- or four-year-old or to make certain of the re and regular breeding habits of any old mares.

eat Periods

The heat periods recur approximately at twenty-one day tervals, with a spread of from eighteen to twenty-seven days. ıe period of duration of heat usually varies from five to eight ys, although some mares will remain in heat up to fifty to sixty ys in the early spring.

GNS OF OESTRUM:

The experienced horseman who is familiar with a band of ares can usually detect those that are in season by observing) the relaxation of the external genitals, (2) more frequent ination, (3) the teasing of other mares, (4) the apparent desire r company, and (5) a slight mucous discharge from the vagina. "shy breeders" or when there is any question about the mare eing in season, she should be "tried" as previously discussed. hen possible, it is usually good business to present mares regu-rly to the teaser every day or every other day as the breeding ason approaches. A systematic plan of this sort will save much me and trouble.

Above all, precaution should be taken against false heats of ares in foal, the breeding of which may result in abortion. Such recaution is obtained by properly teasing the mare under the atchful eye of an experienced horseman who is familiar with ıe peculiarities of the individual animal.

ertilization

Generally, the egg is liberated during the period of one day efore to one day after the end of heat. Unfortunately, there is o reliable way of predicting the length of heat nor the time f ovulation.

The sperm (or male germ cells) are deposited in the uterus t the time of service and from there ascend the reproductive

tract. Under favorable conditions, they meet the egg, and one of them fertilizes it in the upper part of the oviduct near the ovary.

A series of delicate time relationships must be met, however, or the egg will never be fertilized. The sperm cells live only twenty-four to thirty hours in the reproductive tract of the female, and it probably requires four to six hours for them to ascend the female reproductive tract. Moreover, the egg is viable for an even shorter period of time than the sperm, probably for not more than four to six hours after ovulation. For conception, therefore, breeding must take place within twenty to twenty-four hours before ovulation.

As mares usually stay in heat from five to eight days, perhaps the highest rate of conception may be obtained by serving the mare daily or every other day during the heat period, beginning with the third day. When many mares are being bred and heavy demands are being made upon a given stallion, this condition may be obtained by reinforcing a natural service with subsequent daily artificial inseminations as long as heat lasts. In no case should the mare be bred twice the same day.

Gestation Period

The average gestation period of mares is 340 days, or a little over eleven months. This will vary, however, with individual mares and may be as much as twenty or thirty days under or over this period of time.

Breeding After Foaling

Mares usually come in heat seven to eleven days after foaling, with individual mares varying from three to thirteen days after foaling. Provided that foaling has been entirely normal and there is no discharge or evidence of infection at this time, many good horsemen plan to rebreed the mare during this first recurrence of heat after foaling or about on the ninth day. They believe that mares so handled are more likely to conceive than if bred at a later period. Mares suffering from an infection of the genital tract are seldom settled in service; and even if they do conceive, there is danger of the foal being undersized and poorly developed. Furthermore, the infection may be needlessly spread to the stallion and other mares by allowing such a practice. Mares not bred at this time or not conceiving will come in heat approximately every twenty-one days thereafter.

The usual reasons advanced in favor of rebreeding at the st heat period following foaling are:

1. It gives an added chance to rebreed the mare in an effort get her in foal.

2. Occasionally a mare will not again show signs of heat ring the breeding season.

3. If the mare conceives, she will foal about twenty days rlier the following year. This may be important where an early l is desired.

Some arguments against rebreeding on the ninth day follow- g foaling are:

1. If only one service is given on the ninth day following aling, it is estimated that not more than 25 per cent of the ares conceive.

2. During the period extending up to two weeks following aling, the brood mare is more susceptible to genital infection an during any other period of her life.

3. Older mares that have been raising foals regularly each ar, may require a longer period of rest between pregnancies.

4. If the chances of conception are not too great, it may be wise to overwork the stallion deliberately.

It is noteworthy that more and more of the good horsemen Kentucky prefer not to breed mares on the ninth day following aling.

ER CENT OF MARES BRED PRODUCING FOALS

Without question more difficulty is experienced in breeding ares than any other kind of livestock. The percentage of mares red that actually conceive each year will probably vary from 0 to a high of 85, with an average probably running less than 0; and some of this number will fail to produce living foals. In ne bluegrass country of Kentucky, where there are both good orsemen and as desirable conditions for breeding as can be ecured under domestication, 66 per cent foaling is considered s average for the area. Recognition of the following facts may elp to increase the percentage of foals produced:

1. Mares bred in the spring of the year are more likely to onceive. If mares are bred out of season, spring conditions hould be duplicated as nearly as possible.

2. Mares bred as three- and four-year-olds and kept in egular production thereafter are more likely to conceive and roduce living foals.

3. Infections or other unhealthy conditions of either the mare or the stallion are not favorable for production.

4. More conceptions will occur if the mare is bred at the proper time within the heat periods. Usually mares bred just before going out of heat are more likely to conceive.

5. Returning the mares to the stallion for retrial or rebreeding is important.

6. Mares in foal should be fed and cared for properly so as to develop the young. Balance of proteins, minerals, and vitamins is important.

7. It must also be remembered that old mares, overfat mares, or mares in a thin, run-down condition are less likely to be good breeders.

STERILITY OR BARRENNESS IN MARES

Sterility is a condition of infertility. Whatever the cause, there are no "curealls" for the condition. Rather, each individual case requires careful diagnosis and specific treatment for what is wrong. It should be recognized also that there are two types of sterility—temporary and permanent—although no sharp line can be drawn between them.

Regardless of the cause of sterility, it is well to give a word of caution against the so-called "opening up" of mares, which is the practice of inserting the hand and arm into the genital organs for the purpose of rearranging the organs in order to insure conception. Few laymen, no matter how "expert" they may classify themselves, have either sufficient knowledge of the anatomy of the mare or appreciation of the absolutely sterile methods necessary in such procedure to be probing about. Moreover, it is only rarely that the reproductive organs are out of place. Unless the "opening up" is recommended and conducted by a competent veterinarian, it should not be permitted. When performed by an amateur, or even most "would-be experts," it is a dangerous practice that is to be condemned.

Temporary Sterility

Some common causes of temporary sterility might be listed as follows:

1. Lack of exercise, irregular work, and overfeeding accompanied by extremely high condition.

2. Overwork, underfeeding, and an extremely thin and run-down condition.

3. Nutritional deficiencies.

4. Infections of various kinds.

5. Some types of physiological inbalance characterized by uch things as cystic ovaries or failure to ovulate at the proper me.

Temporary sterility can be reduced by removing the cause nd correcting the difficulty, whatever it may be.

ermanent Sterility

Naturally, permanent sterility is much more serious to the orse breeder. Perhaps the most common causes of permanent terility are:

1. Old age, which is usually accompanied by irregular breed-ng and eventual total sterility.

2. Infections in the reproductive tract, usually in the cervix, terus, or fallopian tubes.

3. Some types of physiological imbalances characterized by uch things as cystic ovaries or failure to ovulate at the proper ime.

4. Closure of the female genital organs.

Sometimes a veterinarian is able to correct the latter two onditions; and on an extremely valuable breeding mare, it may e worth while to obtain such professional service in an effort o bring about conception.

Retained afterbirth or other difficulties encountered in foal-ng may cause inflammation and infection that will prevent onception as long as the condition exists. There is real danger f spreading the infection if the mare is bred while in such a ondition.

FERTILITY OF THE STALLION

Any stallion of breeding age that is purchased should be a guaranteed breeder; this is usually understood among reputable breeders.

The most reliable and obvious indication of potency is a large number of healthy, vigorous foals from a season's service. As an added protection, or in order to follow the horse during the midst of a heavy breeding program, a microscopic examination of the semen may be made by an experienced person. As the stallion dismounts from service, some of the semen is collected in a sterilized funnel by holding the penis over the plugged fun-nel. A sample of the semen is then strained through sterile gauze, and a small amount is placed on a slide for examination. A great number of active sperm cells is an indication, although not def-

inite assurance, that the stallion is fertile. Some establishments make a regular practice of making such a microscopic examination twice each week during the breeding season. If it is desired to examine a stallion's semen after the breeding season or when a mare is not in season, an artificial vagina may be used. Semen volume is also a valuable indication of fertility when an entire ejaculate is available for study.

If the stallion is a shy breeder or lacks fertility although one is certain that the feed and exercise have been up to standard, masturbation should be suspected.

CONDITIONING THE MARE FOR BREEDING

Proper conditioning of the mare prior to breeding is just as important as in the stallion. Such conditioning depends primarily upon adequate and proper feed and the right amount of exercise.

For the highest rate of conception, mares should neither be too thin nor too fat; a happy medium in condition makes for best results. It is especially important that one avoid the natural tendency of barren or maiden mares to get too fat.

Time permitting, mares of the light-horse breeds may best be exercised and conditioned by riding under the saddle or driving in harness. Draft mares are usually given exercise through regular work in harness. When these methods are not practical or feasible, permitting a band of mares to run in a large pasture will usually provide a satisfactory amount of exercise.

THE BREEDING OPERATIONS

No phase of horse production has become more unnatural or more complicated with domestication than the actual breeding operations. Recommended precautions will be covered under the following headings: (1) Hand breeding, corral breeding, and pasture breeding, (2) Examination of the mare, and (3) Mating considerations and serving the mare.

Hand Breeding, Corral Breeding, and Pasture Breeding

Hand mating is undoubtedly the best way in which to breed mares; it is the accepted practice in the better breeding establishments throughout the world. It guards against injury to both the stallion and the mare.

Although leaving much to be desired, corral breeding is next best to hand breeding. In this system, after first ascertaining that the mare is in heat, she and the stallion are turned loose together in a small, well-fenced corral. The attendants should

main out of the corral, where they can see but not be seen by e animals, until service is completed, following which the stal-on and the mare are returned to their respective quarters.

Pasture breeding simply consists of turning the stallion into pasture with the band of mares which it is intended that he erve. Except on the ranges of the far West, this method of reeding is seldom practiced with domestic horses. With valuable nimals, both corral and pasture breeding are too likely to cause jury, and the practices should be condemned. In pasture breed-g, a stallion will handle fewer mares because of the repeated ervices of a mare, and he may even become sterile toward the nd of the breeding season. Moreover, in pasture breeding, ccurate breeding records are impossible.

Examination of the Mare

Before accepting a mare for service, the stallion owner hould check every possible condition with care. The stallioner nould examine the mare closely and question the owner concern-ng her health, last foaling date, breeding record, and similar natters. He should be well acquainted with the symptoms of ourine and other venereal diseases. Even though these diseases re not common in this country, there is always danger of finding hem in imported stallions and mares and western horses. It is vise to require that barren mares be accompanied by a health ertificate signed by a veterinarian.

The following types of mares should be rejected:

1. Mares showing the slightest symptoms of venereal dis-ase.
2. Mares that have an abnormal discharge (such as blood r pus) from the vagina, commonly known as the "Whites."
3. Mares affected with skin diseases and parasites.
4. Mares suffering from high fevers, which accompany olds, strangles, influenza, shipping fever, and pneumonia.
5. Mares that have recently foaled colts affected with navel-ll.
6. Mares that have recently suffered from retained after-birth.
7. Mares that have suffered lacerations in foaling.
8. Mares that do not show definite signs of heat.
9. Mares under three years of age unless mature and well developed.
10. Mares that have a very narrow or deformed pelvis.

11. Mares that stay in heat incessantly (nymphomaniacs).

12. Mares that are extremely thin or emaciated.

13. Mares that have severe unsoundnesses which may be hereditary.

When mares have been barren over an extended period or when there is the slightest suspicion of infection, it is good protection to require a veterinarian's certificate to the effect that the mare is in a healthy breeding condition.

Mating Considerations and Serving the Mare

In addition to the above considerations concerning the examination of the mare, the following suggestions may be helpful:

1. Usually the mare should be taken to the stallion as breeding facilities are generally better where a stallion is stood for service.

2. If the mare has a foal and is to be away for a period of longer than five or six hours, the foal should be taken along—care being taken to avoid injury to the foal in transit. When the mare will not be away longer than five to six hours, the foal should be left home, and the mare should be hand-milked if necessary.



Fig. 388. Teasing a mare, using a solid fence for separation. Breeding a mare that is not in season is a wasteful practice, and more important, it may result in damaging the future breeding efficiency. (Courtesy, The State College of Washington.)

3. Newly arrived mares, especially those travelling by public an or railway, may well be required to pass through a quarantine period prior to being bred.

4. The mare should be allowed to become quiet and comfortable upon reaching the destination. Usually the most desirable practice is to tie the mare in a quiet stable. In cold weather or when the mare has been difficult to get in foal, some good horsemen have recommended moderate exercise just prior to mating.

5. If excited or overheated, mares should be cooled out before being bred. Never should the mare be led behind a truck or car, or raced, in going to or returning from the stallion at the time of service.

6. Make certain that the mare is in season and ready for the stallion. Mares are most likely to conceive if bred twenty-four to forty-eight hours before the end of the heat period. The chute, gateway, open door, or solid fence are the usual methods employed for teasing. Breeding a mare that is not absolutely ready is a wasteful practice, and more important, it may result in damaging the future breeding efficiency.

7. After teasing the mare and making certain that she is



Fig. 389. The mare's tail, properly bandaged. This keeps the genital organs clean and avoids interference with tail hairs. (Courtesy, The State College of Washington.)

in season, wash the reproductive organs of the stallion with castile soap and warm water, using cotton instead of a sponge. Then rinse with clean pure water. The reproductive organs should be washed in a similar manner following service.

8. Bandage the upper 6 to 8 inches of the mare's tail using 3-inch widths of cheesecloth or other inexpensive materials. This keeps the genital organs clean and avoids interference with tail hairs. The bandage is removed after service.



Fig. 390. A hobbled mare with twitch, ready for service. Hobbles and twitches are used only to protect the stallion as he approaches and dismounts and not in any way to force the mare into submission to service when not ready. (Courtesy, The State College of Washington.)

9. The external parts of the mare that are likely to come into contact with the reproductive organs of the stallion should be washed with castile soap and warm water and then rinsed with clean water. Use cotton instead of a sponge, and never put any cotton back in the bucket after it has touched the mare.

10. Use the twitch and hobbles for the mare. This assures protection for both the stallion and mare. Hobbles are used only to protect the stallion as he approaches and dismounts and not in any way to force the mare into submission to service when not ready. The twitch is usually removed as soon as the stallion has entered the mare.

11. Keep the stallion under control at all times. Never allow him to mount until he is ready for service. Then allow him to remain on the mare until the sexual act is completed. The same man should always handle the stallion at the time of service.

12. Allow the mare to remain quiet for a time following service. Avoid any undue excitement or exertion. If the mare has been in harness, she should not be worked for two or three days. Feed the mare as she was fed prior to breeding. Some good horsemen have the mare led quietly for twenty minutes following service; for, in moving about, she has no opportunity to strain.

13. Return the mare for retrial approximately twenty-one days following the first service. Such a practice will increase the percentage of in-foal mares and guard against the arrival of colts much later in the season than desired.

SIGNS AND TESTS OF PREGNANCY

Some mares will continue to exhibit the characteristic heat symptoms even when in foal. Sometimes in-foal mares will show such pronounced signs of heat that they will be given the service of the stallion. This often results in abortion. Only the horseman knowing individual mares is capable of passing the best judgment on this question.

In order to produce as high a percentage of foals as possible and to have them arrive at the time desired, the good horseman will be familiar with the signs of and tests for pregnancy. This is doubly important when it is recognized that a great many mares may either be shy breeders or they may show signs of heat even when well advanced in gestation. The signs and tests of pregnancy may be listed as follows:

1. The cessation of the heat period—recognizing that this may be hard to determine and even misleading.

2. The movement of the living fetus. This movement can be seen or felt through the abdominal walls. It will not be possible, however, to use this test until about the seventh month of gestation. Movement of the fetus is most evident the first thing in the morning. This method is not so certain with young maiden mares, as the foal is carried nearer the backbone.

3. A rectal examination made forty to sixty days after the last service in which the uterus is felt through the rectum. This should be done only by an experienced horseman or veterinarian.

The following two biological tests for pregnancy have been developed:

(1) The blood serum test, which may be used on mares any time after forty-five to fifty days following breeding and up to three months. Two ounces (one-half cup) of blood are drawn into a clean bottle, using a largebore needle in the usual manner. The blood is allowed to stand at room temperature for an hour to facilitate the separation of the serum and is then placed in a refrigerator. After the serum has separated, it is poured off and stored in the refrigerator. The blood serum is injected into female rats (twenty-one to twenty-four days of age), using 0.5 cc serum on each animal. During the period extending from 40 to 120 days after conception, the pregnant mare's serum contains a hormone, gonadotrophin, which, when injected into the test animals, causes activation of the ovary and consequent enlargement of the uterus. Observation of these changes may be made in the rat five days after treatment. In comparison with controls, rats treated with the blood serum of pregnant mares show enlarged ovaries and uterus.

(2) The urine test, which is used on mares from three months after breeding until termination. Four ounces of urine (and not blood) are collected in a clean bottle and are used as a sample. The urine test is used on spayed mature female rats or mice causing symptoms of heat in the vagina of treated animals.

CARE AND MANAGEMENT OF THE STALLION

Although certain general recommendations can be made, it should be remembered that each stallion should be studied as an individual, and his care, feeding, exercise, and handling should be varied accordingly.

Quarters for the stallion

The most convenient arrangement for the stallion is a roomy box stall which opens directly into a two- or three-acre pasture paddock, preferably separated from the other horses by a double fence. A paddock fence made of heavy lumber is safest. The stall door opening into such a paddock may be left open except during extremely cold weather; this will give the stallion plenty of fresh air, sunshine, and additional exercise.

Feeding the stallion

The feed and water requirements of the stallion are adequately discussed in Chapter XLIV. In addition to this, it may be well to re-emphasize that, in season, clean lush pastures produced on fertile soils are excellent for the stallion. Grass is the horse's



Fig. 391. Stallion barn at the State College of Washington, with each box stall opening directly into large pasture paddocks separated by a double fence. (Courtesy, The State College of Washington.)

most natural feed, and it is a rich source of vitamins that are so necessary for vigor and reproduction. Perhaps the ideal arrangement in providing pasture for the stallion is to give him access to a well-sodded paddock.

Exercise for the stallion

Regular exercise daily for the stallion is important. It is one of the best means of keeping the horse in a thrifty, natural condition and virile.

Stallions of the light-horse breeds are most generally exercised under the saddle or hitched to a cart. Thus, Standardbred stallions are usually jogged three to five miles daily while drawing a cart. Thoroughbred stallions and saddle stock stallions of all other breeds are best exercised under the saddle for from thirty minutes to one hour daily, especially during the breeding season.

Exercise should not be hurried or hard; the walk and the trot are the best gaits to use for this purpose. After the stallion is exercised, he should be rubbed down and cooled off before he is put up, especially if he is hot. Better yet, the ride should be so regulated at the end that the horse will be brought in cool, in which case he can be brushed off and turned into his corral.

Frequently, in light horses, bad feet exclude exercise on roads, and faulty tendons exclude exercise under the saddle. Un-

der such conditions, one may have to depend upon; (1) exercise taken voluntarily by the stallion in a large paddock, (2) longeing or exercising on a 30- to 40-foot rope, or (3) leading.

Longeing should be limited to a walk and a trot; and, if possible, the stallion should be worked on both hands; that is, made to circle both to the right and to the left. It is also best that this type of exercise be administered within an enclosure. Two pre-



Fig. 392. The Thoroughbred stallion Piccolo in strong breeding condition. This horse is used in the light horse breeding program at The State College of Washington. (Courtesy, The State College of Washington.)

cautions in longeing are: (1) do not longe a horse when the footing is slippery, and (2) do not pull the animal in such manner as to make him pivot too sharply with the hazard of breaking a leg.

Leading is a satisfactory form of exercise for some stallions if it is not practical to ride them. In leading, a bridle should always be used—never a halter—and one should keep away from other horses and be careful that the horse being ridden is not a kicker.

The objection to relying upon paddock exercise alone is that the exercise cannot be regulated, especially during inclement weather. Some animals may take too much exercise and others too little. Moreover, merely running in the paddock will seldom, if ever, properly condition any stallion.

The best and easiest method of providing exercise for the mature draft stallion is to have him in the harness each day. Even during the breeding season, it will be found advantageous to work the stallion half of each day. It should be remembered that there is no better advertisement for the stallion than letting him be seen at work, handled carefully by a good teamster. In addition, the performance of useful work furnishes a means of lowering the cost of keep. Stallions managed in this manner are also more easily handled and of better temperament. When real work cannot be provided, the draft stallion should be led at the walk for a distance of three to five miles daily.

A two- or three-acre grassy paddock should always be provided, even for horses that are regularly exercised. Stallions that are worked should be turned out at night and on idle days. While the pasture paddock is much superior to close confinement and no exercise in a stall, the stallion not being used regularly at useful work will be benefited by any additional forced exercise, even though it does become somewhat monotonous.

Grooming the stallion

Proper grooming of the stallion is necessary, not only to make the horse more attractive in appearance, but to assist in maintaining the best of health and condition. Grooming serves to keep the functions of the skin active. It should be thorough, with special care taken to keep all parts of the body clean and free from any foulness, but not so rough nor severe as to cause irritation either of the skin or temper.

AGE AND SERVICE OF THE STALLION

It should be remembered that the number and kind of colts that a stallion sires in a given season is more important than the total number of services. The number of services allowed during a season will vary with the age, development, temperament, health, and breeding condition of the animals and the distribution of services. Therefore, no definite best number of services can be recommended for any and all conditions, and yet the practices followed by good horsemen are not far different. All are

agreed that excessive service of the stallion may reduce his fertility.

Although stallions of the light-horse breeds are usually not placed in service until they are three years of age, the well-developed, vigorous two-year-old draft stallion may serve ten to fifteen mares, provided that not more than two or three services are allowed each week. In general, there appears to be more difference within breeds than between breeds insofar as the number of services per season may be concerned. However, because of their more naturally nervous temperaments, stallions of the light-horse breeds are usually more restricted in services than stallions of the draft-horse breeds. The average three-year-old, regardless of breed, may serve thirty to forty mares (with a limit of one service a day); a four-year-old fifty to sixty (with a limit of two services a day); and a mature horse eighty to one hundred mares. The most satisfactory arrangement for the well-being of the stallion is to allow not more than one service each day. With proper handling, however, the mature, vigorous stallion may with certainty and apparently without harm serve two mares in a single day. During the heavy spring breeding season, this may often be necessary. It is a good plan to allow a stallion to rest at least one day a week. In the program of the U. S. Remount service, now dissolved, three-year-old stallions were usually limited to fifteen mares; and stallions from four to eighteen inclusive were limited to a book of forty mares. However, even mature stallions within the latter age group were usually limited to twenty-five mares when standing their first season.

In order to secure higher conception of the mares and yet avoid overwork of the stallion with an excessive number of natural services, most Thoroughbred breeders now reinforce each natural service with one artificial insemination.

Stallions often remain virile and valuable breeders until twenty to twenty-five years of age, especially if they have been properly handled. However, it is usually best to limit the number of services on a valuable old sire in order to preserve his usefulness and extend his longevity as long as possible.

Occasionally, Thoroughbred and Standardbred stallions are used to a limited extent before retirement to the stud, although many good horsemen seem to feel that it is not best to use them until it is time for them to be definitely retired. Saddle horses may be bred to a few mares and still be used in the show ring. However, it sometimes makes them more difficult to handle.

It frequently happens that a wonderful horse is injured in the midst of his racing career, and while awaiting the next racing season, he is bred to a few mares.

If two services a day are planned with the mature stallion, one should be rather early in the morning and the other late in the afternoon. It is also best not to permit teasing or services immediately before or soon after feeding the stallion; for this may result in a digestive disturbance, particularly in the nervous, fretful individuals.

CARE OF THE PREGNANT MARE

Barren and foaling mares are usually kept separately because pregnant mares are sedate; whereas barren mares are more likely to run, tease and kick. Precautions in handling the pregnant mare will be covered in the discussion that follows.

Quarters For The Mare

If draft mares are worked in harness, they may be given quarters similar to those accorded to the rest of the work horses, at least until near parturition time. The mares may best be turned to pasture. Even in the winter time, a simple shelter is adequate. In some sections of the country, an open shed is satisfactory.

Feeding The Pregnant Mare

The feed and water requirements for the pregnant mare are adequately discussed in Chapter XLIV and repetition is unnecessary.

Exercise For The Pregnant Mare

The pregnant mare should have plenty of exercise. This is usually best obtained by allowing a band of brood mares to roam over large pastures in which shade, water, and minerals are available. Otherwise, mares of the light-horse breeds should be exercised for an hour daily under the saddle or hitched to a cart.

The most satisfactory and advantageous way in which to provide exercise for the draft brood mare is in harness and under the supervision of a good teamster. Naturally, with the in-foal mare, undue strain and overexertion should be avoided, especially during the latter half of pregnancy. This includes such things as pulling too hard, jerking, wading through deep mud and snow, or packing heavy loads. Usually the more difficult assignments can be given to geldings and to mares not in foal.

When handled carefully, the brood mare should be exercised to within a day or two of foaling. Above all, when not receiving forced exercise or on idle days, she should not be confined to a stable or a small dry-lot. If a pasture is not available for the idle mare, she must be exercised by the horseman.

CARE AT FOALING TIME

A breeding record should be kept on each mare so that it will be known when she is due to foal. As has been previously indicated, the period of gestation of a mare is about 340 days, but it may vary as much as a month in either direction. Therefore, the careful and observant horseman will be ever alert and make certain definite preparations in ample time.

The period of parturition is one of the most critical stages in the life of the mare. Through carelessness or ignorance, all of the advantages gained in selecting genetically desirable and healthy parent stock and in providing the very best of environmental and nutritional conditions through gestation can be quickly dissipated at this time. Generally speaking, less difficulty at parturition was encountered in the wild state, when the females of all species brought forth their young in the fields and glens.

Work and Exercise

If already accustomed to it, the mare may be used for light, slow work right up to foaling time. If she is taken out of the harness one or two days prior to foaling, other gentle exercise, such as leading, should be provided. This is especially important if she has not been accustomed to being on pasture and if it is desired to avoid any abrupt changes in feeding at this time. Saddle or light-harness mares should be exercised moderately in the accustomed manner.

Signs of Approaching Parturition

Perhaps the first sign of approaching parturition is a distended udder, which may be observed two to six weeks before foaling time. About seven to ten days before the arrival, there will generally be a marked shrinking or falling away of the muscular parts of the top of the buttocks near the tailhead and a falling of the abdomen. Although the udder may have filled out previously, the teats seldom fill out to the ends more than four to six days before foaling; and the wax on the ends of the nipples generally is not present until within two to four days before

parturition. About this time, the vulva becomes full and loose. As foaling time draws nearer, milk will drop from the teats; and the mare will show restlessness, break into a sweat, urinate frequently, lie down and get up, etc. It should be remembered, however, that there are times when all signs fail and a foal may be dropped when least expected. Therefore, it is well to be prepared as much as thirty days in advance of the expected foaling date.

Preparation For Foaling

When signs of approaching parturition seem to indicate that the foal may be expected within a week or ten days, arrangements for the place of foaling should be completed. Thus the



Fig. 393. A mare and her new-born foal on pasture. When the weather is warm, the most natural and ideal place for foaling is a clean open pasture away from other livestock. Under these conditions, there is less danger of either infection or mechanical injury to the mare and foal. (Courtesy, National Cottonseed Products Association, Inc.)

mare will become accustomed to the new surroundings before the time arrives.

During the spring, summer, and fall months when the weather is warm, the most natural and ideal place for foaling is a clean open pasture away from other livestock. Under these conditions, there is decidedly less danger of either infection or mechanical injury to the mare and foal. Of course, in following this practice, it is important that the ground be dry and warm. Small paddocks or lots that are unclean and foul with droppings are unsatisfactory and may cause such infectious troubles as "navel-ill."

During inclement weather the mare should be placed in a roomy, well-lighted, well-ventilated, comfortable, quiet box stall which should first be carefully cleaned, disinfected, and bedded for the occasion. It is best that the mare be stabled therein at nights a week or ten days before foaling so that she may become accustomed to the new surroundings. The foaling box should be 16 feet square and free from any low mangers, hay racks, or other obstruction that might cause injury either to the mare or the foal. After the foaling box has been thoroughly cleaned, it should be disinfected to reduce possible infection. This may be done by scrubbing with boiling-hot lye water, made by using one can of lye to 20 gallons of water (one-half this strength of solution should be used in scrubbing mangers and grain boxes). The floors should then be sprinkled with air-slaked lime. Plenty of clean, fresh bedding should be provided at all times.

A foaling box somewhat away from other horses and with a smooth, well-packed clay floor is to be preferred. The clay floor may be slightly more difficult to keep smooth and sanitary than concrete or other such surface materials, but there is less danger to the mare and the newborn foal from slipping and falling; and it is decidedly better for the hoofs.

Feed at Foaling Time

Shortly before foaling, it is usually best to decrease the grain allowance slightly and to make more liberal use of light and laxative feeds, especially wheat bran. If there are any signs of constipation, a wet bran mash should be provided.

The Attendant

A good rule for the attendant is to *be near but not in sight.* Some mares seem to resent the presence of an attendant at this time, and they will delay foaling as long as possible under such circumstances. Mares that have foaled previously and which

have been properly fed and exercised, will usually not experience any difficulty. However, young mares foaling for the first time, old mares, or mares that are either overfat or in a thin, run-down condition may experience considerably difficulty. The presence of the attendant may prevent possible injury to the mare and foal; and when necessary, he may aid the mare or call a competent veterinarian.

Parturition

The immediate indications that the mare is about to foal are extreme nervousness and uneasiness, lying down and getting up, biting of the sides and flanks, switching of the tail, sweating in the flanks, and frequent urination.

The first actual indication of foaling is the rupture of the outer fetal membrane, followed by the escape of a large amount of fluid. This is commonly referred to as the rupture of the "water bag." The inner membrane surrounding the foal appears next, and labor then becomes more marked.

With normal presentation, a mare foals rapidly, usually not taking more than fifteen to thirty minutes. Usually, when the labor pains are at their height, the mare will be down; and it is in this position that the foal is generally born, while the mare is lying on her side with all legs stretched out.

In normal presentation, the front feet, with heels down, come first, followed by the nose which is resting on them, then the shoulders, the middle (with the back up), the hips, and then the hind legs and feet. If the presentation is other than normal, a veterinarian should be summoned at once, for there is great danger that the colt will smother if its birth is delayed. If the feet are presented with the bottoms up, it is good indication that they are the hind ones, and there is likely to be difficulty.

If, after a reasonable time and effort have been expended, a female appears to be making no progress in parturition, it is advisable that an examination be made and assistance be rendered before the animal has completely exhausted her strength in futile efforts at expulsion. In rendering any such assistance, the following cardinal features should exist:

1. Cleanliness.
2. Quietness.
3. Gentleness.
4. Perseverance.
5. Knowledge, skill, and experience.

When parturition is unduly delayed or retarded, the fetus often dies from twists or knots in the umbilical cord, from remaining too long in the passage. In either case, there may be stoppage of fetal circulation or lack of oxygen for the fetus, or both.

If foaling has been normal, the attendant should enter the stable to make certain that the foal is breathing and that the membrane has been removed from its mouth and nostrils. If the colt fails to breathe immediately, artificial respiration should be applied. This may be done by blowing into the mouth of the foal, working the ribs, rubbing the body vigorously and permitting the colt to fall around. Then after the navel has been treated, the mare and foal should be left to lie and rest quietly as long as possible so that they may gain strength.

The Afterbirth

If the afterbirth is not expelled as soon as the mare gets up, it should either be tied up in a knot or tied to the tail of the mare. This should be done so that the foal or mare will not step on the afterbirth and thereby increase the danger of inflammation of the uterus and foal founder in the mare. Usually the afterbirth will be expelled within one to six hours after foaling.

If it is retained for a longer period or if lameness is evident, the mare should be blanketed, and an experienced veterinarian should be called. Retained afterbirth often causes laminitis, which is recognized by lameness in the mare. This is usually treated by feeding easily digested feed for a period of thirty-six hours and by applying cold applications to the mare's feet until the condition is relieved.

To prevent development of bacteria and foul odors, the afterbirth should be removed from the stall and burned or buried in lime as soon as possible.

Cleaning the Stall

Once the foal and mare are up, the stall should be cleaned. Wet, stained, or soiled bedding should be removed. The floor should be sprinkled with lime; and clean, fresh bedding should be provided. Such sanitary measures will be of great help in preventing the most common type of joint-ill.

If the weather is extremely cold and the mare hot and sweaty, she should be rubbed down, dried, and blanketed soon after getting on her feet.

Feed and Water After Foaling

Following foaling, the mare usually is somewhat hot and feverish. She should be given small quantities of lukewarm water at intervals but should never be allowed to gorge. It is also well to feed lightly and with laxative feeds for the first few days. The very first feed might well be a wet bran mash with a few oats or a little oat meal soaked in warm water. About one-half the usual amount should be fed. Usually, for the first week, no better grain ration can be provided than bran and oats. The quantity of feed given should be governed by the milk flow, the demands of the foal, and the appetite and condition of the mare. Usually the mare can be back on full feed within a week or ten days after foaling.

Be Observant

The good horseman will be ever alert to discover difficulties before it is too late. If the mare has much temperature (normal for the horse is about 101° F.) something is wrong, and the veterinarian should be called. As a precautionary measure, many good horsemen take the mare's temperature a day or two after foaling. Any discharge from the vulva should also be regarded with suspicion.

Handling the Newborn Foal

Immediately after the foal has arrived and breathing has started, it should be thoroughly rubbed and dried with warm towels. Then it should be placed in one corner of the stall on clean, fresh straw. The mare will usually be less restless if this corner is in the direction of her head. The eyes of a newborn foal should be protected from a bright light.

THE NAVEL CORD:

At the time the umbilical cord is ruptured, there is a direct communication from without to some of the vital organs and the blood of the foal. Usually this opening is soon closed by the ensuing swelling and final drying and sloughing-off process. Under natural conditions, the wild state, there was little danger of navel infection, but domestication and foaling under confined conditions has changed all this.

To reduce the danger of navel infection (which causes a disease known as joint-ill or navel-ill) the navel cord of the newborn foal should be treated at once with a 10 per cent solution of tincture of iodine. This may be done by placing the end of the

cord in a wide-mouthed bottle nearly full of tincture of iodine while pressing the bottle firmly against the abdomen. This, of course, is best done with a colt lying down. The cord should then be dusted with a good antiseptic power. Dusting with the powder should be continued daily until the stump dries up and drops off and the scar heals, usually in three or four days. If an antiseptic powder is not available, air-slaked lime may be used. Any foreign matter that accumulates on the navel should be pressed out, and a disinfectant should be applied.



Fig. 394. Treating the navel cord of the new-born foal with iodine. This is done by placing the end of the cord in a wide-mouthed bottle nearly full of tincture of iodine while pressing the bottle firmly against the abdomen. (Courtesy, Major C. B. Team, U.S.D.A.)

If left alone, the navel cord of the newborn foal usually breaks within two to four inches from the belly. Under such conditions, no cutting is necessary. However, if it does not break it should be severed about two inches from the belly with clean, dull shears or it may be scraped in two with a knife. Never cut diagonally across. A torn or broken blood vessel will bleed very little; whereas, one that is cut directly across may bleed excessively. If severing of the cord is resorted to, it should be immediately treated with iodine.

NAVEL INFECTION (JOINT-ILL OR NAVEL-ILL):

Although most newborn foal infections are referred to as navel infection—implying that the infection is postnatal, with entrance to the body gained through the umbilical cord after birth—many such troubles are of prenatal origin. In the latter type, infection of the foal takes place in the uterus (womb) of the dam before the foal is born. The infection may either be present in the dam before she is bred, or it may be introduced by the stallion, if he is infected or if he has previously bred other



Fig. 395. Foal dying of navel infection (joint ill or navel ill). The disease is fatal in about 50 per cent of the cases. Also, a large proportion of the animals that survive are left with deformed joints. (Courtesy, Dept. of Veterinary Pathology and Hygiene, College of Veterinary Medicine, University of Illinois.)

infected mares. If prenatal infection does not result in abortion and the mare carries the fetus the normal term, the colt is often born weak or develops navel-ill within a few days and dies; or if it does not die, it becomes a hopeless cripple that must be destroyed.

Under unsanitary conditions, there is also great danger from germs that may enter the blood stream through the opening of the navel cord prior to the time that it has dried up and the scar has healed over. When weather conditions permit foaling on a clean pasture in the fresh air and sunshine, danger of such infection is held to a minimum. On the other hand, foaling in a filthy paddock or stall and with no precautions taken is very likely to result in infection and navel-ill. For this reason, when it is necessary to have mares foal in the stall, every precaution should be taken. The stall should be thoroughly cleaned, disinfected, and bedded;

and the navel should be treated with iodine immediately after the foal arrives and then dusted with a good antiseptic powder several times daily.

Navel infection (joint-ill or navel-ill) may be recognized by a loss of appetite, soreness and stiffness in the joints, and a general listlessness of the foal. If this is recognized in the early stages and a veterinarian is called at once, the infected foal may recover. If, however, the disease has reached the pus-forming stage, it very likely will be fatal. Blood transfusions from the dam to foal have been given in all types of foal infections, usually with good results. With certain specific types of infections, sulfanilamide, serums, or bacterins may be successfully used; but these should always be administered by a competent veterinarian. Prevention is decidedly the best protection.

In summary, it may be stated that the practice of sanitation and hygiene, starting with the stallion and brood mare at the time of mating and continuing with the brood mare and young foal at foaling time, usually prevents the most common type of joint-ill. In certain areas, particularly those known to be goiterous or semi-goiterous, such as the Pacific Northwest, the feeding of stabilized iodized salt to in-foal mares has seemed to reduce losses from joint-ill.

THE COLOSTRUM:

The colostrum is the milk that is secreted by the dam for the first few days following parturition. It differs from ordinary milk in the following aspects:

1. It is more concentrated.
2. It is higher in protein content, especially globulins.
3. It is richer in vitamin A.
4. It contains more antibodies.
5. It has a more stimulating effect on the alimentary tract.

Because of these many beneficial qualities of colostrum, the horseman should make very certain that the newborn foal secures this first milk.

The strong, healthy foal will usually be up on its feet and ready to nurse within thirty minutes to two hours after birth. Occasionally, however, a big awkward foal will need a little assistance and guidance during its first time to nurse. The stubborn foal should be coaxed to the mare's teats (forcing is useless). This may be done by backing the mare up on additional bedding in one corner of the stall and coaxing the foal with a bottle and nipple. The attendant may hold the bottle while standing on the

opposite side of the mare from the foal. The very weak foal should be given the mare's first milk even if it must be drawn in a bottle and fed by nipple for a time or two. Sometimes these weak individuals will nurse the mare if steadied by the attendant.

Aside from the difference in chemical composition, the colostrum (the milk yielded by the mother for a short period following the birth of the young), seems to have the following functions:



Fig. 396. Assisting new-born foal to nurse. (Courtesy, Major C. B. Team, U.S.D.A.)

1. It contains anti-bodies that temporarily protect the foal against certain infections, especially those of the digestive tract.
2. It serves as a natural purgative, removing fecal matter that has accumulated in the digestive tract.

This, therefore, explains why mares should not be milked out prior to foaling and why colostrum is important to the newborn foal.

Before allowing the foal to nurse for the first time, it is usually good practice to wash the mare's udder with a mild disinfectant and to rinse it with clean, warm water.

BOWEL MOVEMENT OF THE FOAL:

The regulation of the bowel movement in the foal is very important. Two common abnormalities are constipation and diarrhea or scours.

Impaction in the bowels of the excrement accumulated during the development prior to birth—material called meconium—may prove fatal if not handled promptly. Usually a good feed of colostrum will cause elimination, but not always—especially when colts are foaled by stall-fed mares.



Fig. 397. Giving an enema to a foal, using a tube and can. (Courtesy, Major C. B. Team, U.S.D.A.)

Bowel movement of the foal should be observed within four to twelve hours after birth. If by this time there has been no discharge and the colt seems rather sluggish and fails to nurse, it should be given an enema. This may be made by using a quart of water at blood heat, to which a little glycerin has been added. The solution may be injected with a baby syringe (one having about a 3-inch nipple) or a tube and can. This treatment may be repeated as often as necessary until the normal yellow feces appear.

If the foal is scouring, the ration of the mare should be reduced, and a part of her milk should be taken away by milking her out at intervals.

Diarrhea or scours in foals may be associated with infectious diseases or may be caused by unclean surroundings. Any of the following conditions may bring on diarrhea: contaminated udder or teats; nonremoval of fecal matter from the digestive tract; restfulness or temperature above normal in the mare; an excess of feed affecting the quality of the mare's milk; cold, damp bed; or continued exposure to cold rains. As treatment is not always successful, the best practice is to avoid the undesirable conditions.

Diarrhea is caused by an irritant in the digestive tract that should be removed if recovery is to be expected. Only in exceptional cases should an astringent be given with the idea of checking the diarrhea.

RAISING THE ORPHAN FOAL:

Occasionally a mare dies during or immediately after parturition, leaving an orphan foal to be raised. There also are times when mares fail to give a sufficient quantity of milk for the newborn foal. Sometimes there are twins. In such cases, it is necessary to resort to other milk supplies. The problem will be simplified if the foal has at least received the colostrum from the dam, for it does play a very important part in the well-being of the newborn young.

If at all possible, the foal should be shifted to another mare. Some breeding establishments regularly follow the plan of breeding a mare that is a good milk producer but whose foal is expected to be of little value. Her own foal is either destroyed or raised on a bottle, and the mare is used as a foster mother or nurse mare. If this cannot be done, cow's milk should be made as nearly as possible of the same composition of mare's milk. A comparison of the two is given in table 76.

TABLE 76

COMPOSITION OF MILK FROM COWS AND MARES[1]

Source	Water %	Protein %	Fat %	Sugar %	Ash %
Cow	87.18	3.55	3.69	4.88	0.75
Mare	90.78	1.99	1.21	5.67	0.35

[1]U. S. Dept. of Agri. Farmers' Bulletin No. 803.

As can be observed, mare's milk is higher in percentage of water and sugar than cow's milk and is lower in other components.

For best results in raising the orphan foal, milk from a fresh cow, low in butterfat, should be used. To about a pint of milk,

add a tablespoon of sugar and from three to five tablespoonsful of lime water. Warm to body temperature and for the first few days feed about one-fourth of a pint every hour. After three or four weeks the sugar can be stopped, and at five or six weeks skim milk can be used entirely.

For the first few days, the milk may be fed by using a bottle and a rubber nipple. The foal then should be taught to drink from a pail. It is important that all receptacles be kept absolutely clean and sanitary (clean and scald each time) and that feeding be at regular intervals. Grain feeding should be started at the earliest possible time with the orphan foal.

NORMAL BREEDING SEASON AND THE TIME OF FOALING

The most natural breeding season for the mare is in the spring of the year. Usually mares are gaining in flesh at this time; the heat period is more evident; and they are more likely to conceive. Furthermore, the springborn foal may be dropped on pasture—with less danger of infection and with an abundance of exercise, fresh air, and sunshine to aid in his development. There will also be good, green, succulent pasture for the mare. Such conditions are ideal.

However, when the demands for working the mares are such that spring foaling interferes and fall or perhaps late-winter foals are desired, plans may be changed accordingly. Under such circumstances, spring conditions should be duplicated at the breeding season. That is, the mare should be fed to gain in flesh and, if necessary, should be blanketed for comfort.

Suitable stabling facilities and other equipment for the proper care of the foal should not be overlooked.

It must also be remembered that the showman will want to give consideration to having the foals dropped at such a time that they may be exhibited to the best advantage. The same applies to the person who desires to sell well-developed yearlings of the light-horse breeds or to race two-year-olds.

HOW TO LOWER THE COST OF RAISING HORSES

Some management principles that should receive consideration in lowering the cost of raising horses are as follows:

1. Begin using horses moderately at two years of age, at which time their use should more than compensate for the feed cost.



Fig. 398. Mares and foals on pasture. The cost of raising horses can be materially lessened by utilizing pastures to the maximum. (Courtesy, The State College of Washington.)

2. Keep all horses of usable age earning their way. Animals that are not necessary or that do not increase in value at a profitable rate are a needless expense.

3. Utilize pastures to the maximum; such a practice will supply nutritious feeds at a low cost and save time in feeding, will reduce man labor in caring for the horses, and will do away with bedding the stalls and cleaning the barn.

4. Utilize the less salable roughage as much as possible, particularly during the second and third years.

5. Do not construct or maintain costly quarters for the young, growing horse.

6. Keep animals free from parasites, both internal and external. Feeding parasites is always too costly.

7. Provide a balanced ration, including a balance of proteins, necessary minerals, and vitamins. Plenty of good, clean water should also be available at all times.

BUYING HORSES OR RAISING COLTS

Where horses or mules are needed, they must either be purchased or colts must be raised. The primary factors to consider in determining whether horses will be bought or colts raised are: (1) the experience of the individual, (2) comparative cost, and (3) risks surrounding the introduction of horses.

Experience of the Horseman

Certainly it must be recognized that the man who would attempt to raise replacements must have more knowledge of



Fig. 399. A horse auction in progress. These horses were shipped in from the state of Iowa and sold at auction at Springfield, Massachusetts. (Photo by M. E. Ensminger.)

horse production than the person buying mature horses. In addition to knowing the regular care and management aspects of horse production, the man who raises his replacements must be somewhat familiar with the breeding of horses and the rearing of foals.

Comparative Cost

In determining whether horses will be bought or colts raised, the comparative cost of the two methods should be computed. In arriving at such comparative cost figures the following factors should be remembered:

1. Such figures should be on the basis of animals of equal merit and usefulness for the purpose desired. Consideration should also be given to age and future depreciation.

2. Computing the purchase price on horses should be on the basis of price delivered to the farm. Commission, freight or trucking, and insurance charged should not be overlooked.

3. In computing the cost of raising a foal to usable age, feed price should be figured on the basis of farm values rather than on actual grain market values. Consideration should also be given to the fact that cheap and somewhat unsalable rough-

ages may often be used. Such items as service fees, manure produced, and handling charges should also be considered.

Risks Surrounding the Introduction of Horses

After giving full consideration to the experience of the horseman and the comparative cost of the two methods, there still are some rather perplexing problems encountered in introducing horses. These difficulties may be summarized as follows:

1. **Misrepresentations.**—The inexperienced man, especially, is likely to encounter misrepresentations as to age, soundness, vices, and the training and usefulness of the horse.

2. **Diseases.**—In moving a horse, there is always a possible exposure to the many ills. Sometimes these are of sufficiently serious nature as to make working impossible at a time when the animal is most needed; occasionally they even prove fatal. It must also be remembered that such diseases as are contracted may very likely spread to the other horses on the farm and even to those in the community, thus exposing them to the same risk.

3. **Acclimating.**—Horses coming from a distance usually need time to become acclimated before being most useful.

4. **Condition.**—In all too many instances, horses brought in for sale and speculative purposes have been made fat for the occasion. Usually such liberal feeding has been made even more harmful through accompanying lack of work and confinement to a stall. Such horses are soft and require a period of gradual fitting for work. It must also be remembered that fat will cover up a multitude of defects.

REGISTRATION OF FOALS PRODUCED THROUGH ARTIFICIAL INSEMINATION

Ironically enough, although artificial insemination was first practiced in horses, many American horse registry associations now frown upon the practice. Moreover, there is little unanimity of opinion among them so far as their rules and regulations apply to the practice. The Tennessee Walking Horse Breeders' Association and the Standard Jack and Jennet Registry will record foals sired artificially without any questions being asked. The Shire, Clydesdale, Shetland Pony, Welsh Pony, Palomino, and Quarter Horse Breeders' Associations have, as yet, made no rulings on the registration of such foals.

Percheron and Belgian foals are eligible only if the mare and stallion were on the same farm at the time semen was taken and

the mare impregnated. The Standard Bred Horse Breeders' Association requires affidavits from the stallion owner, the owner of the mare, and the veterinarian making the insemination before a foal will be accepted for registry. The Cleveland Bay and Suffolk registries will accept foals produced artificially provided that adequate evidence is furnished.

The American Saddle Horse Breeders' Association will accept for registration colts produced by artificial insemination, providing, (1) the insemination takes place on the premises where the stallion is standing, and (2) the insemination takes place in the presence of the owner or party authorized to sign certificates of breeding for the stallion used.

Thoroughbred foals are not eligible for registration unless begotten by natural service, although it is permitted to reinforce at once the natural service by artificial insemination with semen from the stallion performing the natural service on the mare that has just been covered.

Foals produced by artificial insemination are not eligible for registration in the Arabian, Morgan, or American Hackney Associations.

STALLION ENROLLMENT LAWS

Twenty-two states have stallion enrollment laws, enacted to bring about the improvement of horses and mules through the control of the public service stallions and jacks. The first stallion law was passed by the legislature of Wisconsin in 1906. In 1907, Minnesota and Iowa enacted similar laws. Other states soon followed suit. Although the laws vary considerably between states, all have similar objectives. They are designed to accomplish one or more of the following things:

1. To prevent false representation as to breeding.
2. To bar heritably unsound and diseased horses.
3. To label unsound horses and jacks.
4. To eliminate the inferior sire, whether he be scrub, grade, or purebred.

At the time these stallion laws were enacted, there was much controversy among horse breeders concerning the heritability of certain unsoundnesses and diseases; consequently, many were listed that are not now considered transmissible from parent to offspring. Even now, there is no unanimity of opinion relative to the inheritance of certain unsoundnesses, and new information is constantly revising past thinking. For example, it is now

known that periodic ophthalmia (moon blindness) may be prevented by adding the vitamin, riboflavin, to the ration.

At the present time, the majority of stallion enrollment laws bar from public service stallions that are affected with any of the following unsoundnesses or diseases: bone spavin, ringbone, sidebone, heaves, stringhalt, roaring, blindness, glanders (farcy), malakie-du-coit, and urethral gleet.

Although much improvement in the horse population has come about through existing stallion legislation, still further progress can be achieved through making the laws more rigid. Perhaps the time has arrived when all such laws should be amended to incorporate the following provisions:

1. Include privately used stallions as well as those stood for public service.
2. License only purebred registered stallions of approved type.
3. Revise the list of hereditary unsoundnesses and transmissible diseases, and license only stallions that are free from these afflictions.
4. Scrutinize the qualifications of the veterinarians who inspect the stallions.
5. Classify stallions relative to: (1) conformation, (2) performance (track record, show record, etc.), (3) breeding, and (4) progeny performance (the record of the get).
6. "Put teeth into the law" by providing for enforceable penalties for violations.
7. Provide simple lien laws for protection of the stallion owner.

COMMERCIAL HYBRIDS WITH THE HORSE AS ONE PARENT

The mule, representing a cross between the jack (male of the ass family) on the mare (female of the horse family) is the best known hybrid in the United States. The resulting offspring of the reciprocal cross of the stallion mated to a jennet is known as the hinny.

Rarely have mules proved fertile; only five authentic cases of mare mules producing foals have been reported in the United States. This infertility of the mule is probably due to the fact that the chromosomes will not pair and divide equally in the reduction division.

The offspring of fertile mules are horse-like in appearance, showing none of the characteristics of the mule's sire (or ass). It is not likely, therefore, that the eggs (ova) which produce them carry chromosomes from the ass; they are likely pure horse eggs without any inheritance from their maternal grandfathers. This indicates that in the production of eggs in mare mules the reduction division is such that all of the horse chromosomes go to the egg and none to the polar bodies.

The zebroid, a zebra x horse hybrid, is rather popular in certain areas of the tropics because of its docility and resistance to disease and heat.



Fig. 400. It has been said that the mule has no pride of ancestry and no hope of posterity, but "Old Beck"—a bay "cotton-type" mule owned by Texas A. and M. College, was an exception. Shown above is Old Beck and her second living foal, a "horse-like offspring sired by a stallion and foaled 9 26/23. The colt was fertile and sired a number of living foals. (Courtesy. Prof. J. C. Miller, Texas A. & M. College.)

LETHALS IN HORSES

The term lethal refers to a genetic factor that causes death of the young, either during prenatal life or at birth. Lethals which have been reported in horses include the following:

1. **Abnormal sex ratio.**—This is a recessive condition caused by a sex-linked gene, which was first reported in the Oldenburger

breed of horses. Ratios of fifty-five males to ninety females were reported. About one-half of the males died before birth or during the early stages of prenatal development.

2. **Atresia.**—This is a recessive condition characterized by closure of the ascending colon. It was reported in Japan as occurring among the descendants of a Percheron stallion imported from Ohio. Affected foals stand with difficulty, soon develop colic, and die.

3. **Lethal white.**—This low fertility was first reported as occurring in the white horses of the Frederiksborg stud. Some have assumed that factors destroying either gametes or zygotes were responsible.

4. **Stiff forelegs.**—This factor, probably a recessive, results in foals being born with stiff forelegs.

PRODUCTION TESTING HORSES

The breeders of race horses have always followed a program of mating animals of proved performance on the track. For example, it is interesting to note that the first breed register which appeared in 1791—known as "An Introduction to The General Stud Book,"—recorded the pedigrees of all the Thoroughbred horses winning important races. In a similar way, the Standardbred horse—which is an American creation—takes its name from the fact that, in its early history, animals were required to trot a mile in two minutes and thirty seconds, or to pace a mile in two minutes and twenty-five seconds, before they could be considered as eligible for registry. The chief aim, therefore, of the early-day breeders of race horses was to record the pedigree of outstanding performers rather than all members of the breed.

The simplest type of progeny testing in horses consists of the average record or merit of an individual stallion's or mare's offspring. Thus, the offspring of Thoroughbreds or Standardbred animals bred for racing may be tested by timing on the track. Less satisfactory tests for saddle horses, harness horses, and draft horses have been devised. However, it is conceivable that actual exhibiting on the tanbark in the great horse shows of the country may be an acceptable criterion for saddle and harness-bred animals. Also, the dynamometer might conceivably be used for testing animals of draft-horse breeding, although it has not been so used in the past.

CHAPTER XLIV

FEEDING HORSES

Despite the decline in horse and mule numbers in the United States during the past two decades, it is estimated that to feed and care for these equines requires a total expenditure of approximately a billion dollars per year. Even so, less attention is given to the economical and balanced feeding of horses than to the feeding of any other class of large animals.

Skill and good judgment in feeding enter into the success or failure of feeding horses even more than that of any other class of stock. Under similar conditions, two trainers may secure widely different results. In one stable, the horses have nerve, speed, and endurance—ample evidence that the animals are in the best of condition. In the other, the lack of speed, dull eye, and rough coat show, better than words can express, the lack of judgment in feeding and management. The unsatisfactory condition may not necessarily be brought about by any saving at the feed bin or haymow. Indeed, the good trainer will usually feed his animals the most economically.

The principles of successful horse feeding are, however, simple and easily understood. If the few necessary rules and precautions are observed and good judgment is used at all times, there should be no difficulty in maintaining horses in fit condition.

The nutritional requirements of horses are not fundamentally unlike those of other domestic animals. Thus, for maintenance, growth, fattening, reproduction, and work (running), the horse has need for proteins, carbohydrates, fats, minerals, and vitamins. The relative importance of the various nutrients and the quantities required by horses are, however, not the same as for the other farm animals.

The primary difference in nutritive requirements are due to the fact that: (1) Horses are kept for work (or running), whereas the other farm animals are kept as meat producers; and (2) the small digestive tract of the horse does not permit as much use of roughage as is possible with the ruminants.

The main qualities desired in race horses are speed and endurance. These cannot be obtained with large, paunchy stomachs

or lack of energy that may result from excessive use of roughage. Moreover, in horses used for speed, the carrying of every pound of surplus body weight must be avoided. The effect of the feed on the character of the muscles formed from it, and especially on the nerve and mettle of the horse, is also to be considered.

Although the requirements of the draft horse are less exacting, the same general principles as outlined for light horses apply.

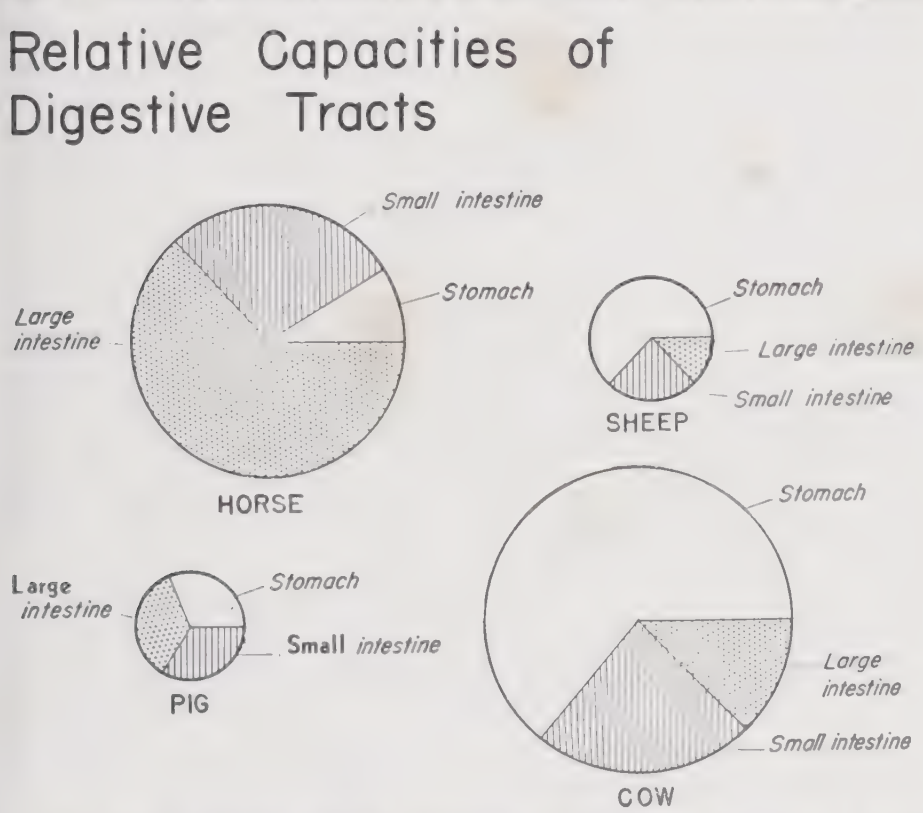


Fig. 401. Diagram showing comparative capacities of digestive tracts of different classes of farm animals. Note that the horse has a relatively small stomach. (Drawing by R. F. Johnson.)

SPECIFIC NUTRITIVE NEEDS OF HORSES AND MULES

The various nutritive needs of the horse will be discussed under the following headings: (1) Protein needs, (2) Energy needs, (3) Mineral needs, (4) Vitamin needs, and (5) Water needs.

Protein Needs

In horse feeding, especially when grass hays are fed, protein is frequently the limiting factor in the ration. This is due to the fact that the common farm grains and grass hays are deficient in

both quantity and quality of proteins for best results. The protein in the ration is of special importance for young, growing colts and for brood mares that are suckling young. Requirements of these animals are much greater than those of other classes of horses.

The common farm grains are inadequate as sources of proteins, and the quality of the proteins is poor. They are also low in calcium; and except for the carotene in yellow corn and peas, they are poor sources of vitamins. On the other hand, early-cut, green, leafy, sun-cured legumes and young, luxuriant pastures are high in proteins, minerals (especially calcium in the legumes), and vitamins (especially carotene—the precursor of vitamin A, and in vitamin D, riboflavin, and many other of the B vitamins).

Although the horse is not a ruminant, a considerable amount of bacterial synthesis does take place in the caecum, the blind gut of the horse. Because of this arrangement, it is not necessary that the mature horse be provided with good quality proteins—proteins of animal origin, such as milk by-products, meat scraps or tankage, or fish meal. Rather, the ration of the horse may be balanced entirely with the less expensive proteins of plant origin—particularly legume hays and pastures that are produced on fertile soils.

An exception to the bacterial action occurs in the case of colts and young animals of other classes of stock. There is much less bacterial synthesis of proteins early in life. Thus, up until weaning age, quality of proteins is very important for the young, growing colt. Fortunately, the milk of the lactating mother fully meets these requirements during this period of life.

The proportion of proteins required in the ration decreases as the colt becomes older. Naturally, when protein-rich feeds are inexpensive, larger quantities of them may be provided. Usually, the protein requirements can be met through the proper combination of legume hays or pastures and farm-grown grains. Thus the young, growing colts, pregnant mares, or suckling mares should always be provided with such legumes as alfalfa, clover, or lespedeza forage; whereas, the grasses and other non-legume roughages are satisfactory for mature idle horses.

Energy Needs

Energy is essential for the necessary normal life processes of the animal, including body maintenance, reproduction, and lactation. After these requirements are met, surplus energy may

be used in performing work or may be stored as body fat. The energy requirements for work are determined almost entirely by the individuality and size of the animals and the kind, amount, and severity of the work performed. The chief sources of heat and energy in the diet of horses are the carbohydrates and fats. Nitrogenous feeds (protein feeds) are seldom used for this purpose because of their high cost and inefficiency for this purpose. Carbohydrates are the most abundant nutrients of all common feeds. They are especially high in the cereal grains and in cereal-grain by-products. Fats, which are high in such feeds as peanuts and soybeans, have an energy value about 2.25 times as great as that of an equal weight of carbohydrates or protein.

Lack of adequate amounts of energy-producing feeds in the rations of horses may result in a number of consequences. In young colts, an energy deficiency usually causes slow and stunted growth, with consequent underdevelopment; whereas, mature animals lose weight, get out of condition, and show excessive fatigue with work. When the energy requirements of breeding stock and idle horses are not satisfied, the most noticeable effect is a loss in body weight.

Mineral Needs

The minerals that are most likely to be deficient in rations for horses are common salt, calcium, phosphorous, and iodine.

Salt, in either granulated or block form (preferably the former), should always be available in the stall, paddock, or pasture. When salt is fed free-choice, only enough to meet the body requirements will be consumed. But with irregular use, an abnormal appetite develops for salt, and this is often followed by an excessive consumption and digestive troubles if unlimited access is allowed.

On the average, a horse will consume 1½ to 2 ounces of salt daily. When at hard work during warm weather—conditions accompanied by profuse perspiration and consequent loss of salt in the sweat—even greater quantities may be required. Unless this salt is replaced, the animal will soon exhibit signs of excessive fatigue. Overheating of horses seldom occurs if the animals are allowed free access to salt at all times and are given water at frequent intervals.

In some sections of the country, such as the northwestern part of the United States, iodine deficiencies are prevalent. In these areas, unless iodine is provided to the pregnant mare, foals

are often either born weak or develop navel-ill. There may even be beneficial results in such deficient areas from supplying horses other than pregnant mares with iodine. It is sound protection to always feed *stabilized iodized salt* in areas known or suspected to be deficient in iodine.

Except for pregnant and lactating mares and young, growing foals, the entire calcium and phosphorous requirement of horses usually can be met through providing feeds (including pastures)



Fig. 402. Yearlings getting salt. On the average, a horse will consume 1½ to 2 ounces of salt daily. It is always wise to feed stabilized iodized salt in those areas known or suspected to be deficient in iodine. (Courtesy, University of Massachusetts.)

that were produced on well-fertilized soils. This is not only the easiest way in which to meet these particular requirements, but possible mineral and other nutrient inbalances are minimized when natural feed sources are relied upon.

When feeds are produced in areas of unknown origin or on soils suspected or known to be deficient in calcium and phosphorous, steamed bone meal (a source of both calcium and phosphorous) should be provided free-choice for all horses, regardless of age or sex. Even when feeds are produced on fertile soils, it is a good protection to provide bone meal for young, growing colts and pregnant and lactating mares—animals that have a high calcium and phosphorous requirement. If there is no need

for the additional minerals, the animal will not consume them; and certainly there is little added cost for the protection afforded by the practice.

Perhaps the most satisfactory method of providing bone meal and salt for horses consists of building a box with a double compartment, with salt on one side and a mixture of $\frac{1}{3}$ salt and $\frac{2}{3}$ steamed bone meal on the other. The mineral box should always be protected from rain.

Vitamin Needs

Certain vitamins are necessary in horse rations in order to permit proper growth, development, health, and reproduction. Although the particular role played by vitamins in the nutrition of the horse has not been explored extensively, there is reason to suppose that the vitamin requirements of the horse are similar to those of other farm animals. Certainly deficiencies of vitamins A and D are encountered. Although very little information is available, indications are that some of the B group of vitamins, especially riboflavin, are required by the horse.

A severe deficiency of vitamin A may cause night blindness, reproductive failure, uneven and poor hoof development, degeneration of nerves, and a predisposition to respiratory diseases. There is also some practical evidence which probably indicates that a lack of vitamin A may cause or contribute to certain bone and joint disorders such as rheumatic disease, osteo-arthritis, stringhalt, certain types of lameness, and eroded joints.

Foals sometimes develop rickets, caused by lack of vitamin D or of calcium or phosphorous. This condition may be prevented by exposing the animal to direct sunlight as much as possible, by allowing access to a suitable mineral mixture, and by providing good quality sun-cured hay or luxuriant pasture grown on well-fertilized soils. In areas lacking in sunshine, many leading Thoroughbred breeders provide the foal with a vitamin-D supplement, such as cod liver oil.

Recent work by the United States Remount Service at the Front Royal, Virginia, station indicates that periodic ophthalmia (commonly called moon blindness) may be prevented by adding riboflavin to the ration. Riboflavin probably is necessary for the synthesis of ocular vitamin C, or its protecting substance.

Fortunately, vitamins A, D and the B vitamins (including riboflavin) may all be provided through natural sources. Green hays, green silage, and green pastures are unexcelled as sources



Fig. 403. Foal with severe rickets. Note the enlarged joints and crooked legs. Rickets may be caused by a lack of vitamin D or of calcium or phosphorus. (Courtesy, Dept. of Veterinary Pathology and Hygiene, College of Veterinary Medicine, University of Illinois.)

of riboflavin and of carotene, which is the substance from which vitamin A is made by the animal body. Ample quantities of vitamin D can be manufactured by the animal itself provided that there is exposure of the body to direct sunlight. Sun-cured hay is also an excellent source of vitamin D.

Although concentrated doses of vitamins A and D can be obtained through feeding cod liver oil and crystalline riboflavin can be purchased at the corner drug store, it is to be emphasized that best results are obtained when vitamins are supplied through natural sources. Moreover, less cost and greater palatability is to be obtained through natural feeds. The combination of high quality, leafy green roughages and plenty of sunshine is usually adequate protection against vitamin deficiencies in horses.

Water Needs

Water is essential to the various physiological processes of the horse. Although variable, the average mature horse will consume about 12 gallons daily and even larger quantities when sweating excessively. In addition to the type and severity of work performed, weather conditions and the kind of feed consumed also affect the quantity of water desired.

There is a diversity of opinion as to the proper time and method of watering horses. Perhaps, however, all would agree that regularity and frequency of watering are desirable and that it is dangerous to water heavily a horse that is very warm or one that has been deprived of water for a long time.

There seems to be considerable controversy among horsemen as to the proper time of watering in relationship to feeding. Some insist that animals should always be watered prior to feeding, whereas others are equally vociferous in claiming that horses should never receive water until after eating. The consensus of opinion on watering horses indicates that water may be given either before, during, or after feeding without injurious effects. Watering cups permit such a procedure. In the final analysis, it may be concluded that individual convenience and the preference of the horse will largely determine the watering practice to be followed. In any event, however, regularity in the established system should always be followed.

Frequent but small watering between feedings are desirable during warm weather or when the animal is put to hard use. In fact, it is always better to water frequently in small quantities than to allow the animal to gorge itself at any one time.

Before allowing access to water or feed, riding horses should be ridden slowly for the last mile, and the groom should walk race horses under a blanket for a minimum of twenty minutes following vigorous exercise.

FEEDS FOR THE HORSE

The numerous feeds for the horse, for purposes of convenience, may be grouped as follows: (1) pastures, (2) hays, (3) silages, and (4) concentrates. As a general rule, one should feed roughages and concentrates of acceptable quality that are most readily available at the lowest possible cost. Strong prejudice to the contrary, horses may satisfactorily use a great variety of feeds. In some parts of the world, they are fed such unusual feeds

as the leaves of limes and grapevines, lawn clippings and garden refuse, garbage, bamboo leaves, and dried fish.

Pasture For The Horse

The great horse breeding centers of the world are characterized by luxuriant pastures produced on fertile soils. Thus the vast majority of the Thoroughbreds and American Saddle Horses of Kentucky are grazed on lush bluegrass pastures produced on residual limestone soils. In season, there is no finer forage for horses than clean, luxuriant pastures produced on fertile soils—



Fig. 404. Mares and foals on lush pastures. The great horse breeding centers of the world are characterized by luxuriant pastures produced on fertile soils. (Courtesy, Major C. B. Team, U.S.D.A.)

pastures that are much more than mere gymnasiums for horses. This is especially true of idle horses, brood mares, and young stock. In fact, pastures have a very definite place for all horses, with the possible exception of animals at heavy work or in training. Even with the latter groups, pastures may be used with discretion. Farm work horses may be turned to pasture at nights or over the week end. The total benefits derived from pasture are to the good, although pasturing may have some laxative effects and produce a greater tendency to sweat.

In addition to providing needed minerals, vitamins, and other nutrients, pastures provide invaluable exercise on natural footing—with plenty of sunshine, fresh air, and lowered feeding costs

as added virtues. Feeding on pasture is the ideal existence for young stock and breeding animals.

The use of a temporary pasture—grown in a regular crop rotation—instead of a parasite-infested permanent pasture is recommended.

Legume pastures are excellent for horses, as these farm animals are less subject to bloat than cattle or sheep. The specific grass or grass-legume mixture will vary from area to area, according to differences in soil, temperature, rainfall, etc. The county agricultural agent, local agricultural instructor, and state agricultural college can furnish recommendations for the areas they serve.

Horse pastures should be well drained and not too rough or stony; and all dangerous places—such as pits, stumps or poles, tanks, etc.—should be guarded. Shade, water, and minerals (salt and bone meal) should be available in all pastures.

Hay For The Horse

Through mistaken kindness or carelessness, horses are often fed too much hay or other roughage, and labored breathing and quick tiring is the result. With cattle and sheep, on the other hand, it is usually well to feed all the roughage they will eat. This difference between horses and ruminants is due primarily to the relatively small size of the simple stomach of the horse in comparison with the four-fold stomach of the ruminant.

When limiting the allowance of roughage, it is sometimes necessary to muzzle greedy horses (gluttons) to prevent them from eating the bedding.

Usually, young horses and idle horses can be provided with an unlimited allowance of hay. But one should gradually increase the grain and decrease the hay as work or training begins.

Much good will result from feeding young and idle horses more roughage and less grain.

The hay should be early cut, leafy, green, well cured, and free from dust and mold. Hay native to the locality is usually fed. However, horsemen everywhere prefer good quality timothy. With young stock and breeding animals especially, it is desirable that a sweet grass-legume mixture or alfalfa hay be fed. The legume provides a source of high quality proteins and certain minerals and vitamins.

Horses like variety. Therefore, if at all possible, it is wise to have more than one kind of hay in the stable. For example,

timothy may be provided at one feeding and a grass-legume mixed hay at the other feeding. Good horsemen often vary the amount of alfalfa fed, for increased amounts of alfalfa in the ration will increase urination and give a softer consistency to the bowel movements. This means that elimination from kidneys and bowels can be carefully regulated by the amount and frequency of alfalfa feedings. Naturally, such regulation becomes more necessary with irregular use and idleness. On the other hand, in some areas alfalfa is fed as the sole roughage with good results.

Silage For The Horse

Well-preserved silage of good quality, free from mold and not frozen, affords a highly nutritious succulent forage for horses during the winter months. As horses are more susceptible than cattle or even sheep to botulism or other digestive disturbances resulting from feeding poor silage, none but choice, fresh silage should ever be fed.

Various types of silages may be fed successfully to horses, but corn silage and grass-legume silage is most common. If the silage contains much grain, the concentrate allowance should be reduced accordingly.

Good as the silage may be, it should not be used as the only roughage for horses. Usually it should be fed in such quantity as to replace not more than one-third to one-half of the roughage ration, considering that ordinarily 1 pound of hay is equivalent to approximately 3 pounds of wet silage. This means that the silage allowance usually does not exceed 10 to 15 pounds daily per head for mature animals, although much larger amounts have been used satisfactorily in some instances. Silage is especially suited for the winter feeding of idle horses, brood mares, and growing colts.

Concentrates For The Horse

Unlike ruminants, horses cannot handle very large quantities of roughages. Moreover, horses in heavy work or pleasure or racing horses must be even more restricted in their roughage allowance and should receive a higher proportion of concentrates.

Because of less bulk and lower shipping and handling costs, the concentrates used for horse feeding are less likely to be locally grown than the roughages. Even so, the vast majority of grains fed to horses are home grown, thus varying from area to area, according to the grain crops best adapted.

Of all the concentrates, heavy oats most nearly meet the needs of horses; and, because of the uniformly good results obtained from their use, they have always been recognized as the leading grain for this class of animals. Corn is also widely used as a horse feed, particularly in the central states. Despite occasional prejudice to the contrary, barley is a good horse feed. As proof of this fact, if such evidence is necessary, it might be pointed out that the Arab—who was a good horseman—fed barley almost exclusively. It is to be emphasized, therefore, that careful attention should be given to the prevailing price of feeds available locally, for many feeds are well suited to horses. Often substitutions can be made that will result in a marked saving without affecting the nutritive value of the ration.

Regardless of the feeds selected, they should be of sound quality and not moldy, spoiled, or dusty. This applies to both hay and grain. This careful selection of feeds is more important for horses than for any other class of livestock.

FEEDING LIGHT HORSES

The main qualities desired in light horses—which are used for driving, riding or racing—are trimness, action, spirit, and endurance. These qualities cannot be obtained with large, paunchy stomachs or lack of energy, which may result from excessive use of roughage. Moreover, in most light horses a healthy condition is desired, but excess fat is the bane of the horseman. This is especially important in horses used for racing, where the carrying of every pound of surplus body weight must be avoided.

Light horses are given somewhat more grain and less hay in proportion to weight than draft horses. Among light horsemen, heavy oats and clean, bright timothy hay easily rank first among the grains and hays, respectively. However, all horses like variety, and many other feeds can be used to advantage. Thus a small amount of crushed barley or wheat, wheat bran, cracked corn, or commercial mixed feed may be used along with oats. When corn or other heavy grains are fed, it is important that a little linseed meal or wheat bran be used. The roughage ration may also be improved by providing a variety, which may be obtained through alternating the feeding of a legume with timothy or some other suitable grass hay or by feeding a grass-legume mixture.

About 6 to 12 pounds of grain daily is an average ration for a light horse at medium or light work. Race horses in training

usually consume 10 to 16 pounds of grain per day—the exact amount varying with the individual requirements and the amount of work. The hay allowance averages about one to one and one-fourth pounds daily per hundred pounds live weight.

Light feeders should not be overworked. With all light horses, the hay allowance should be restricted as the grain allowance is increased. Moreover, it is to be emphasized that with greater speed the animal requires proportionally greater energy. During off-work seasons, pastures may be used to advantage for the idle horse—with or without grain, depending upon the individuality and condition of the horse. Suggested rations for light horses are given in Table 77 at the end of this chapter.

FEEDING WORK HORSES AND MULES

The proper nutrition of work horses and mules is a major factor in determining their efficiency and years of service. The quantity of grain and hay required by work animals depends primarily upon (1) the age, size, and condition of the animals, and (2) the kind, regularity, amount, and speed of work performed. Thus a horse requires considerably more feed when performing work at a trot than at a walk. A hard keeper also will require considerably more feed than an easy keeper when doing the same amount of work.

Because the horse has a rather limited digestive capacity, the amount of concentrates must be increased and the roughages decreased when the energy needs rise with the greater amount, severity, or speed of work. The following are general guides for the daily ration of horses under usual conditions:

1. **For horses at light work.**—Allow about $\frac{1}{2}$ pound of grain and $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds of hay per 100 pounds of live weight.

2. **For horses at medium work.**—Allow about 1 pound of grain and 1 to $1\frac{1}{4}$ pounds of hay per 100 pounds of live weight.

3. **For horses at hard work.**—Allow about $1\frac{1}{4}$ to $1\frac{1}{3}$ pounds of grain and 1 pound of hay per 100 pounds live weight.

As will be noted from these recommendations, the total allowance of concentrates and hay should be within the range of 2.0 to 2.5 pounds daily per 100 pounds live weight. No grain should be left from one feeding to the next, and all edible forage should be cleaned up at the end of each day.

The frequency and distribution of the feeds has a great deal to do with their utilization and the condition of the horse. The grain ration is usually divided into three equal feeds, given

morning, noon, and night. Because a digestive tract distended with hay is a hindrance in hard work, it is best to feed most of the hay at night. The common practice is to feed one-fourth of the daily hay allowance at each of the morning and noon feedings and the remaining one-half at night, when the animals have plenty of time in which to eat leisurely.

The regular practice of turning horses and mules on pasture at nights and on idle days is good for the health and well-being of the animals and decreases the quantity of grain and hay required. If the horse must be confined to the stall on idle days, the grain ration should be reduced by 50 per cent in order to avoid azoturia or other digestive disturbances. When idle, it is also well to add some bulky, laxative wheat bran to the ration. A mixture of two-thirds grain and one-third bran is quite satisfactory. Many good horsemen regularly give a feeding of bran, either dry or as a wet mash, on Saturday night.

In selecting a ration for work horses and mules, the feeds should be confined principally to those grown on the farm or ranch. Such feeds are cheaper; and with judgment, a satisfactorily balanced ration may be obtained.

Mules should be given about the same kinds and amounts of feeds as horses, although they are less fastidious in their taste and will consume forages that horses will refuse. Mules also are much less likely to founder or overeat than horses. Consequently, many southern plantation owners allow their mules free access to a feeder or bunk filled with corn or other concentrated feeds. Self-feeding is not uncommon among mule dealers who are fattening large numbers of animals for market.

FEEDING THE BROOD MARE

Brood mares need a ration that will meet their own body needs plus those of the fetus or one furnishing the nutrients required in suckling the foal. If work is also being performed, additional energy feeds must be provided. Moreover, in the young, growing mare, additional protein, minerals, and vitamins, above the ordinary requirements, must be provided. Otherwise, the fetus will not develop normally, or milk will be produced at the expense of the tissues of the dam.

Most of the growth of the fetus occurs during the last third of pregnancy. Thus the reproductive requirements are greatest during this period. As with the females of all species, the nutritive requirements for milk production in the mare are much

more rigorous than the pregnancy requirements. As a lactating mare may give from 3 to 9 gallons of milk per day, it can be appreciated that her feed requirements during the suckling period may not be far different from those of a high-producing dairy cow. In general, it is important that the ration of the gestating-lactating mare should supply sufficient energy; ample protein, calcium and phosphorous; and vitamins A and D (the D being provided through the feed if the animal is not exposed to sunlight), and riboflavin.

Idle brood mares may be satisfactorily and economically fed by providing as nearly year-round pasture as possible plus good-quality legume or grass-legume mixed hay during the winter months. If, for any reason, the animals lose condition when fed in this manner, a limited grain supplement may be provided. Brood mares should be kept in thrifty condition, but they should not be allowed to become too fat.

The correct feeding of a working brood mare is often more simple than the feeding of an idle one for the condition of the animal can be more carefully regulated under working conditions. In addition to a ration that will meet the maintenance and work requirements largely through high-energy feeds, the working brood mare needs a reasonable supply of protein, calcium, and phosphorus with which to take care of the growth of the fetus and/or milk production.

The brood mare should be fed and watered with care immediately before or after foaling. For the first twenty-four hours after parturition, she may have a little hay and a limited amount of water from which the chill has been taken. A light feed or bran or a wet-bran mash is suitable for the first feed and the following meal may consist of oats or a mixture of oats and bran. A reasonably generous allowance of good quality hay is permissible after the first day. If confined to the stable, as may be necessary in inclement weather, the mare should be kept on a limited and light grain and hay ration for about ten days after foaling. Feeding too much grain at this time is likely to produce digestive disturbances in the mare; and, even more hazardous, it may produce too much milk, which may cause indigestion in the foal. If weather conditions are favorable and it is possible to allow the mare to foal on a clean, lush pasture, she will regulate her own feed needs most admirably.

In comparison with geldings or unbred mares, the following differences in feeding gestating-lactating brood mares should be observed:

1. A greater quantity of feed is necessary—usually about 20 to 50 per cent more—the highest requirement being during lactation.

2. Dusty or moldy feed and frozen silage should be avoided in feeding all horses but especially so in feeding the brood mare, for such feed may produce complications and possible abortion.

3. More proteins are necessary for the brood mare. Usually this requirement can be met through providing lush pastures or good quality legume hay.

4. More attention must be given to supplying the necessary minerals and vitamins.

5. The bowels should be carefully regulated through providing regular exercise and through feeding such laxative feeds as bran, linseed oil meal, and alfalfa hay.

6. A few days before and after foaling, the ration should be decreased and lightened by using wheat bran.

7. Pastures should be used to the maximum; and when the brood mare is confined to the stall, at least half of the hay allowance should consist of a legume hay.

8. Regular and ample exercise is a necessary adjunct to proper feeding of the brood mare.

FEEDING THE STALLION

"Reduce the ration and increase the exercise when the stallion is not a sure breeder" has been the advice given to many worried stallion owners. In all too many instances, little thought is given to the feeding and care of the stallion, other than during the breeding season. The program throughout the entire year should be such as to keep the stallion in a vigorous, thrifty condition at all times. Immediately before the breeding season, the feed might very well be increased in quantity so that the stallion will gain in weight. The quantity of grain fed will vary with the individual temperament and feeding ability of the stallion, the work and exercise provided, services allowed, available pastures, and quality of roughage. Usually this will be between ¾ and 1½ pounds daily of the grain mixture per 100 pounds weight, together with a quantity of hay within the same range.

During the breeding season, the stallion's ration should contain more proteins and additional minerals and vitamins than are given in rations fed regular farm work horses or stallions not in service. During the balance of the year (when not in

service) the ration for the stallion may be like that of other horses similarly handled.

In addition to the grain and roughage, there should be free access to steamed bone meal and salt. These should be placed in separate compartments of a suitable box. During the winter months or when little work or exercise is provided, the stallion should receive such succulent feeds as carrots or silage (the silage should be neither moldy nor frozen). Laxative feeds such as wheat bran or linseed meal should also be supplied at these times. Plenty of fresh, clean water should be provided at all times. Drugs or stock tonics should not be fed in an attempt to increase virility.

In season, clean and lush pastures produced on fertile soils are excellent for the stallion. During the fall and winter months, animals should not be turned out on frosty grass, which may cause colic. Perhaps the ideal arrangement in providing pasture for the stallion is to allow him access, for at least part of the day, to a well-sodded paddock. As a substitute, grass may be cut and brought fresh to the stable, or the animal may be grazed on a shank for at least half an hour daily.

Overfitted, heavy stallions should be regarded with suspicion, for they may be uncertain breeders. On the other hand, a poor, thin, run-down condition is also to be avoided.

FEEDING THE YOUNG HORSE

As with all young mammals, milk from the dam assures the foal of the best possible start in life. Within thirty minutes to two hours after birth, the foal should be up on its feet and getting the colostrum.

Feeding Foals Before Weaning

When the foal is between ten days and three weeks of age, it will begin to nibble on a little grain and hay. In order to promote thrift and early development and to avoid set-back at weaning time, it is important to encourage the foal to eat supplementary feed as early as possible. For this purpose, a low-built grain box should be provided especially for the foal; or, if on pasture, the colt may be creep-fed. Rolled oats and wheat bran, to which a little brown sugar has been added, will prove to be especially palatable as a starting ration. A little later, crushed or ground oats, cracked or ground corn, wheat bran, and a little linseed meal may be provided with good results.

In addition to his grain ration, the foal should be given good quality hay (preferably a legume) or pasture. At four to five weeks of age, the normal healthy foal should be consuming 1½ pound of grain daily per 100 pounds live weight. By weaning time, this should be increased to about ¾ pound or more per 100 pounds live weight. The exact amount will vary with the individual, the type of feed, and the development desired.

Free access to stabilized iodized salt and steamed bone meal should be provided. The mineral will be utilized to best advantage if placed in a convenient place and under shelter. Plenty of fresh water should be available at all times.



Fig. 405. A colt creep built around a hay rack. With this arrangement, the colt can be fed separately from the dam. (Courtesy, Major C. B. Team, U.S.D.A.)

Under such a system of care and management, the foal will become less dependent upon its dam, and the weaning process will be facilitated. If properly cared for, foals will normally attain one-half of their mature weight during the first year. Most Thoroughbred and Standardbred breeders plan to have the animals attain full height by the time they are two years of age. However, such results require liberal feeding from the beginning.

Breeders of horses, other than Thoroughbreds and Standardbreds raced at an early age, will probably find it more economical to plan a program of less rapid development. It is well recognized

that the forced development of race horses must be expertly done if the animals are to remain durable and sound. On the other hand, a foal stunted in the first year by insufficient feeding cannot be properly developed later in life.

The Weanling

Perhaps the most critical period in the entire life of a horse is that space from weaning time (about six months of age) until one year of age. Foals suckling their dams and receiving no grain may develop very satisfactorily up to weaning time. However, lack of preparation prior to weaning and neglect following the separation from the dam, may prevent the animal from gaining proper size and shape. The primary objective in the breeding of horses is the economical production of a well-developed, sound individual at maturity. To achieve this result requires careful care and management of the weanlings.

As previously indicated, no great set-back or disturbances will be encountered at weaning time provided that the colts have developed a certain independence from proper grain feeding during the suckling period. Generally speaking, weanlings should receive 1 to 1½ pounds of grain and 1½ to 2 pounds of hay daily per each 100 pounds live weight. The amount of feed will vary somewhat with the individuality of the animal, the quality of roughage, available pastures, the price of feeds, and whether the weanling is being developed for show or sale. Naturally, animals being developed for show or sale should be fed more liberally, although it is equally important to retain clean, sound joints, legs, and feet—conditions which cannot be so easily obtained in heavily fitted animals.

Because of the rapid development of bone and muscle in weanlings, it is important that, in addition to ample quantity of feed, the ration also provide for quality of proteins, minerals, and vitamins. Generally speaking, if a balanced ration of good variety is provided—with at least one half of the roughage consisting of a good quality legume hay and with plenty of salt available—these needs will be fairly well met. Even then, additional minerals should be supplied by allowing free access to steamed bone meal. Oats, corn, barley, and peas are all suitable grains. Grains with harder seed coats should preferably be ground or rolled. Wheat bran, linseed oil meal, cottonseed oil meal, soybean oil meal, dry-rendered tankage, or gluten feed may be used as protein supplements.

The Yearling

If colts have been fed and cared for so that they are well grown and thrifty as yearlings, usually little difficulty will be experienced at any later date.

During the second summer, colts should be turned to pasture as soon as the grass is old enough not to be washy. The change from dry feed to pasture should be gradual in order to avoid any digestive disturbances. Pastures not only provide economical and nutritious feed; but of equal importance to the young and developing animal, they provide plenty of exercise, fresh air, and sunshine. Temporary pastures should be provided for parasite control.

With good, luxuriant pastures produced on fertile soils, usually no grain feeding will be necessary unless the grass becomes dry and parched during the hot summer months, at which time it may be necessary to supplement with a light feeding of grain twice daily. Perhaps even some hay should be provided. Colts that are being grown for show or sale should be fed while on pasture. They should be kept up in the daytime during the hot days and turned out at night. This point needs to be emphasized when forced development is desired; for good as pastures may be, they are roughages rather than concentrates.

The winter feeding program for the rising two-year-olds should be such as to produce plenty of bone and muscle rather than fat. However, except for Thoroughbreds and Standardbreds to be raced at an early age or animals being fitted for show and sale, it is not necessary that the feed provided weanlings be of the superior quality. A larger part of the roughage may consist of the less salable corn stalks, straws, and cheaper hays. In all cases, however, dusty and moldy feeds are to be avoided. From ½ to 1 pound of grain and 1 to 1½ pounds of hay should be fed for each 100 pounds live weight. The quantity will vary with the quality of the roughage, the individuality of the animal, and the use for which the animal is produced. In producing for sale, naturally more liberal feeding may be economical. Access to salt and to steamed bone meal should be provided at all times. An abundance of fresh, pure water should be available.

The Two- And Three-Year-Olds

Except for the fact that the two- and three-year-olds will be larger and, therefore, will require more feed, their proper care

and management is merely a repetition of the principles that have already been discussed for the yearling.

With the two-year-old that is to be raced, however, the care and feeding at this time becomes a matter of extreme importance. Once the young horse is placed in training, the ration should be adequate enough to allow for continued development and to provide necessary maintenance and additional energy for work. This means that special attention must be given to providing adequate proteins, minerals, and vitamins in the ration. Overexertion must be avoided; the animal must be properly groomed, and the feet must be well cared for. In brief, every precaution must be taken if the animal is to remain sound—a most difficult task when animals are raced at an early age, even though the right genetic make-up and the proper environment are present.

During the summer months, pastures grown on well fertilized soils—together with plenty of shade, water, and minerals—provide the ideal nutritive needs for the two- or three-year-old that is not in training or is not being fitted for show or sale. During the hot fly season, the animals may be kept in a darkened but clean stall or shed in the daytime and may be turned to pasture at night.

Because of the splendid exercise afforded, winter pastures should also be provided for the two- or three-year-old if at all possible. Because of the usual leached condition of winter forages, however, hay and grain should also be provided.

FEEDING HORSES FOR THE MARKET; FITTING FOR SHOWS

Each year, many horses and mules are either fattened for market or fitted for shows. In both cases, a fattening process is involved, but in fitting horses for shows exercise is doubly essential.

In general, the feeder of market draft horses and mules merely uses the corral for exercise. But for horses that are being fitted for shows the conditioning process is also a matter of hardening, and the horses are used daily in harness or under saddle. Regardless of whether the market or show is the major objective, fleshing should be obtained without sacrificing action or soundness or without causing filling of the legs and hocks.

In fattening horses, the animals should be brought to full feed rather gradually, until the ration reaches a maximum of about 2 pounds of grain daily for each 100 pounds of live weight.

When on full feed, horses make surprising gains. Increases of 4 pounds daily are not uncommon. Such animals soon become fat, sleek, and attractive. This is probably the basis for the statement that "fat will cover up a multitude of sins in a horse."

Although exercise is desirable from the standpoint of keeping the animals sound, it is estimated that such activity decreases the daily rate of gains by as much as 20 per cent. Because the greater cost of gains and the expense involved in bringing about forced exercise, most feeders of market horses and mules limit the exercise to that obtained naturally from running in a paddock.

In comparison with fattening cattle or sheep, there is more risk in fattening horses and mules. Heavily fed horses kept in idleness are likely to become blemished and injured through playfulness, and there are more feedlot sicknesses among horses and mules than in other classes of stock.

In fitting show horses, the finish must remain firm and hard, the action superb, and the soundness unquestioned. Thus they must be carefully fed, groomed, and exercised to bring them to proper "bloom." Training is also extremely important in preparing for the show ring.

FEED ALLOWANCE AND SOME SUGGESTED RATIONS[1]

At all times, the eye of the master must regulate the amount of feed given to each individual animal; each animal does differ from another, just as do people, in food habits and tendency to put on weight. Moreover, the age and degree of activity of horses are quite important factors.

Oats, corn, and barley—all farm-grown concentrates—are the grains most commonly used for horses; whereas, wheat bran, linseed oil meal, soybean oil meal, and cottonseed meal are the favored supplements to the grains. Alfalfa, clover, soybean, timothy, prairie grass, Johnson grass, lespedeza, cereal hays and dried corn and sorghum fodder constitute the chief forages fed to horses. To be sure, the concentrate and roughage combination used varies in different sections of the United States—home-grown feeds and economy being the primary determining factors. Horses of the West, for example, are largely fed on barley and alfalfa or cereal hay; in the northern Mississippi Valley, the ration consists of oats and corn with timothy or mixed hay for roughage; whereas in the deep South, corn is the leading grain

[1]Where possible these rations were computed from the requirements as reported by the National Research Council and interpreted by the author.

and Johnson grass, lespedeza, and corn fodder the chief roughages.

The addition of a few sliced carrots to the ration and an occasional bran mash, or a small amount of linseed meal, are particularly desirable during the wintering period. Such feeds may also be used in regulating the bowels at other times as required. Such cooling feeds should also be given to horses whose legs must undergo blistering or firing; for they reduce the tendency toward feverish, inflammatory symptoms. Care must be taken to prevent the animal from getting flabby or washy from too much "soft feed" while undergoing treatment. Whether working or idle, the trainer must never relax his vigilant observation nor let his judgment sleep.

The horse feeder should give consideration to the (1) quality, availability, and cost of feeds; (2) the character and severity of the work; and (3) the age and individuality of the animal.

Table 77 is a Handy Light Horse Feeding Guide.

TABLE 77

HANDY LIGHT HORSE FEEDING GUIDE[1]

(Horses for Recreation and Sport)

Age, sex, and use	Daily Allowance	Kind of hay[2] (More than one kind of hay makes for variety and appetite appeal. In season, any good pasture can replace part or all of the hay except for horses at work or in training.)	Suggested grain rations[2] (With all rations and for all classes and ages of horses, provide free access in separate containers to (1) salt (iodized salt in iodine-deficient areas) and (2) a mixture of 1/3 salt and 2/3 steamed bone meal).		
			Ration No. 1	**Ration No. 2**	**Ration No. 3**
ons in breeding season (weighing 00 to 1,400	3/4 to 1 1/2 lbs. grain per 100 lbs. live wt., together with a quantity of hay within same range	Grass legume mixed (or 1/3 to 1/2 legume hay, with balance grass hay)	Oats —55 lbs. Wheat —20 lbs. Wheat bran—20 lbs. Linseed O.M. — 5 lbs.	Corn —35 lbs. Oats —35 lbs. Wheat —15 lbs. Wheat bran—15 lbs.	Oats —(alone)
			(Preceding and during the breeding season, some owners add 1 to 2 ounces of wheat germ oil to the ration twice weekly, thinking that they make the stallions more sure breeders thereby)		
ant mares hing 900 to lbs.)	3/4 to 1 1/2 lbs. grain per 100 lbs. live wt., together with a quantity of hay within same range	rass-legume mixed (or 1/3 to 1/2 legume hay, with balance grass hay (straight grass hay may be used first half of pregnancy)	Oats —80 lbs. Wheat bran—20 lbs.	Barley —45 lbs. Oats —45 lbs. Wheat bran—10 lbs.	Oats —95 lbs. Linseed O.M. — 5 lbs.
s before weaning weighing 100 50 lbs. with cted mature of 900 to) lbs.)	1/2 to 3/4 lb. grain per 100 lbs. live wt., together with a quantity of hay within same range	Legume hay	Oats —50 lbs. Wheat bran—40 lbs. Linseed O.M. —10 lbs.	Oats —30 lbs. Barley —30 lbs. Wheat bran—30 lbs. Linseed O.M. —10 lbs.	Oats —80 lbs. Wheat bran—20 lbs.
			(Rations balanced basis of following assumptions: (1) Mares of lighter breeds (about 900 lbs. mature wt.) will give foals about 4 1/2 gal. milk daily; and (2) mares of heavier breeds (about 1,400 lbs. mature wt.) will give foals about 6 to 6 1/2 gal. milk daily).		
weanlings ghing 350 to bs.)	1 to 1 1/2 lbs. grain and 1 1/2 to 2 lbs. hay per 100 lbs. live wt.	Grass-legume mixed (or 1/3 to 1/2 legume hay, with balance grass hay)	Oats —30 lbs. Barley —30 lbs. Wheat bran—30 lbs. Linseed O.M. —10 lbs.	Oats —70 lbs. Wheat bran—15 lbs. Linseed O.M. —15 lbs.	Oats —80 lbs. Linseed O.M. —20 lbs.
yearlings: summer ghing 450 to bs.)	Good luxuriant pastures (If in training or for other reasons without access to pastures, the ration should be intermediate between the adjacent upper and lower groups)				
yearling or g 2-yr.-old; winter (weighing 700 to 1,000	1/2 to 1 lb. of grain and 1 to 1 1/2 lbs. hay per 100 lbs. live wt.	Grass hay	Oats —80 lbs. Wheat bran—20 lbs.	Barley —35 lbs. Oats —35 lbs. Bran —15 lbs. Linseed O.M. —15 lbs.	Oats—(alone)
t horses at k, in riding, ving, and ng (weighing to 1,400 lbs.)	**Hard Use**—1 1/4 to 1 1/3 lbs. grain and 1 to 1 1/4 lbs. hay per 100 lbs. live wt.				
	Med. Use—3/4 to 1 lb. grain and 1 to 1 1/4 lbs. hay per 100 lbs. live weight.	Grass hay	Oats—(alone)	Oats —70 lbs. Corn —30 lbs.	Oats —70 lbs. Barley —30 lbs.
	Light use—2/5 to 1/2 lbs. grain and 1 1/4 to 1 1/2 lbs. hay per 100 lbs. live wt.				
ature idle ses; stallions, es and geld- (weighing 900 1,400 lbs.)	1 1/2 to 1 3/4 lbs. of hay per 100 lbs. live wt.	Pasture in season; or grass-legume mixed hay	(With grass hay, add 3/4 lb. daily of a high protein supplement)		

[1]Grateful acknowledgement is given to the able assistance of four of the author's WSC colleagues in the preparation of se rations. Mr. James Nolziger computed each ration, and Dr. Burch H. Schneider, Mr. Charles Kyd, and Mr. Gene Stark made ful suggestions and criticisms. Where possible, these rations were computed from the requirements as reported by the National search Council and interpreted by the author.

[2]Good quality oats and timothy hay have always been considered the standard feeds for light horses. However, feeds of ilar nutritive properties can be interchanged in the ration as price relationships warrant. This makes it possible at all times to ain a balanced ration at the lowest cost. Some of these feeds are: (1) the grains (oats, corn, barley, wheat, and sorghum); (2) the tein supplements (linseed oil meal, soybean oil meal, and cottonseed oil meal), and (3) hays of many varieties.

Reference

Added chapters on Buildings and Equipment for Horses and Mules; Horse and Mule Health, Disease Prevention, and Parasite Control; and Equitation are included in the following book by the same author and the same publisher as **Animal Science:**

Horse Husbandry

APPENDIX

ANIMAL UNITS

An animal unit is a common animal denominator, based on feed consumption. It is assumed that one mature cow or one mature horse represents an animal unit. The comparative (to a mature cow or a mature horse) feed consumption of other age groups or classes of animals determines the proportion of an animal unit which they represent. For example, it is generally estimated that the ration of one mature cow or one mature horse will feed five "hogs raised to 200 pounds." For this reason, the "animal units head" on this class and age of animals is 0.2. Table I gives the animal units for different classes and ages of livestock:

TABLE I

ANIMAL UNITS

Type of Livestock	Animal Units per Head
Horses	1
Cows	1
Bulls	1
Young cattle, one year old	0.5
Calves	0.25
Colts	0.5
Brood sows or boars	0.4
Hogs raised to 200 pounds	0.2
Ewes or bucks	0.14
Lambs	0.07
Poultry (per 100)	1
Chickens raised (per 200)	1

WEIGHTS AND MEASURES OF COMMON FEEDS

In calculating rations and mixing concentrates, it is usually necessary to use weights rather than measures. However, in practical feeding operations it is often more convenient for the farmer or rancher to measure the concentrates. Table II will serve as a guide in feeding by measure.

TABLE II

WEIGHTS AND MEASURES OF COMMON FEEDS

Feed	Approximate weight	
	Lbs. per quart	Lbs. per bushel
Alfalfa meal	0.6	19
Barley	1.5	48
Beet pulp (dried)	0.6	19
Brewers' grain (dried)	0.6	19
Buckwheat	1.6	50
Buckwheat bran	1.0	29
Corn, husked ear	--	70
Corn, cracked	1.6	50
Corn, shelled	1.8	56
Corn meal	1.6	50
Corn-and-cob meal	1.4	45
Cottonseed meal	1.5	48
Cowpeas	1.9	60
Distillers' grain (dried)	0.6	19
Fish meal	1.0	35
Gluten feed	1.3	42
Linseed-oil meal (old process)	1.1	35
Linseed-oil meal (new process)	0.9	29
Meat scrap	1.3	42
Molasses feed	0.8	26
Oats	1.0	32
Oats ground	0.7	22
Oat middlings	1.5	48
Peanut meal	1.0	32
Rice bran	0.8	26
Rye	1.7	56
Soybeans	1.8	60
Tankage	1.6	51
Velvetbeans, shelled	1.8	60
Wheat	1.9	60
Wheat bran	0.5	16
Wheat middlings, standard	0.8	26
Wheat screenings	1.0	32

SIZE OF SILO

The importance of proper silo size was emphasized in Chapter IV. The discussion and Tables III, IV, and V which follow pertain to methods of calculating (1) the correct diameter and height of an upright (or pit) silo, and (2) the proper dimensions of a trench silo.

Table III may be used as a guide in computing the diameter of silo for any given farm or ranch.

TABLE III

MAXIMUM DIAMETER OF SILO TO BUILD IF SILAGE IS TO BE KEPT FRESH

Inches of silage removed daily	Total Silage Removed Daily With An Inside Silo Diameter of—					
	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Summer: 3 in. daily will remove	700	1,000	1,400	1,800	2,200	2,800
Winter: 1½ in. daily will remove	350	500	700	900	1,100	1,400

If it is intended that silage shall be fed to calves at the rate of 30 pounds per head daily during the winter months and if the stockman has 30 head of animals and no increase in the herd is planned, a total of 900 pounds of silage will be fed daily. If, as is recommended, a minimum of 1½ inches of silage is to be removed daily in order to alleviate winter spoilage, the diameter of the silo should not be greater than 16 feet.

Table IV may be used as a guide in determining both the proper height (or depth) and diameter of a silo. These figures are for corn or sorghum silage.

If 900 pounds of silage is fed daily for a period of 240 days, a total of 108 tons will be required for the season. Allowance should be made for a minimum of 1 ton spoilage and wastage. That gives a total of 109 tons. As may be noted from Table IV,

TABLE IV

CAPACITY OF SILOS WITH DIFFERENT DIAMETERS AND DEPTHS OF SILAGE[1]

Depth of Silage (feet)	Capacity with an inside diameter of—										
	8 feet	10 feet	11 feet	12 feet	13 feet	14 feet	15 feet	16 feet	17 feet	18 feet	20 feet
	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
20	18	27									
22	19	30	37								
24	21	34	41	49							
26	24	38	46	55	65						
28	27	43	52	61	72	84					
30	30	47	57	68	80	92	106	121			
32	32	51	62	74	87	100	115	131	148		
34		56	67	80	94	109	125	142	161	180	
36		61	73	86	101	117	135	153	173	194	
38			79	93	109	126	145	165	186	209	258
40				100	117	135	155	177	200	224	276
42				108	124	144	165	188	212	237	293
44					132	153	174	198	224	251	310
46							184	209	236	265	327
48								220	248	279	344
50									261	293	361

[1] *Silos, Types and Constructions*, U. S. Dept. of Agri., Farmers' Bulletin, No. 1820, Revised 1948, p. 6.

109 tons of silage may be stored in a silo 14 feet in diameter and 34 feet in height. To allow for settling, an additional 4 to 6 feet should be added to the height, thus making a 38 to 40 foot silo.

As in an upright silo, the cross-sectional area of a trench silo should be determined by the quantity of silage to be fed daily. The length is determined by the number of days of the silage feeding period. The only difference is that generally greater allowance for spoilage is made in the case of trench silos, though this factor varies rather widely.

Under most conditions, it is recommended that a minimum 4-inch slice be fed daily from the face (from the top to the bottom of the trench) of trench silos during the winter months, with a 1-foot slice fed during the summer months. Actually, most practical operators dig back into the trench and feed from successive 3- to 5-foot slices, removing enough silage from the top of each slice to meet the daily requirement.

The dimensions, areas, and capacities given in Table V are based on the assumption that the silage weighs 35 pounds[1] per cubic foot, which is an average figure for corn or sorghum silage. Thus, a trench silo 8 feet deep, 6 feet wide at the bottom, and 10

TABLE V

DIMENSIONS, CROSS-SECTION AREA OF TRENCH SILO, AND WEIGHT OF SILAGE IN 4-INCH SLICE AND PER LINEAL FOOT[2]

Side slope per foot of depth (inches)	Depth	Bottom width	Top width		Cross-sectional area	Weight of silage	
						4-inch Slice	1-foot Slice
	Feet	Feet	Feet	Inches	Sq. Feet	Pounds	Pounds
3	4	5	7	0	24	280	840
4	4	6	8	8	29	338	1,015
5	4	7	10	4	33	385	1,155
3	6	6	9	0	45	525	1,575
4	6	7	11	0	54	630	1,890
5	6	8	13	0	63	735	2,205
3	8	6	10	0	64	747	2,240
4	8	7	12	4	77	898	2,695
5	8	8	14	8	91	1,062	3,185
3	10	6	11	0	85	992	2,975
4	10	8	14	8	113	1,318	3,955
5	10	10	18	4	142	1,657	4,970

[1] With all types of silos — including above-ground and below-ground types—the weight of a cubic foot of silage varies with the kind and maturity of material, moisture content, length of cut, rate of filling, and depth of the silo. Corn silage harvested when about 75 per cent of the grain has passed the milk stage and containing approximately 70 per cent moisture is considered average silage. Volume for volume, sorghum silage weighs about the same as corn silage. Grass or grass-legume silage is 10 to 12 per cent heavier than corn silage, thus requiring more reinforcing in silo construction and making it possible to use a smaller silo for the same tonnage.

[2] *Silos, Types and Construction*, U. S. Dept. of Agri., Farmers' Bulletin No. 1820, Revised 1948, p. 55.

feet wide at the top has a cross sectional area of 64 feet. This size silo will hold 2,240 pounds of silage for each foot in length, or 112 tons in a trench 100 feet long. With this information available, the length of the trench silo can be varied according to the length of the silage feeding period.

About 8 feet for a trench silo is the most economical depth from the standpoint of cost and feeding. Of course, in filling it is desirable to pile silage 3 feet higher over the center of the trench and round it off. This provides for settlement.

ESTIMATING STEER WEIGHTS FROM HEART GIRTH MEASUREMENTS[1]

It is highly desirable to know the weight of steers at various stages during the fattening process so that (1) rations can be evaluated, (2) rate of gain can be calculated, and (3) show ring classification can be determined.

Frequently suitable scales on which to weigh animals are not available. Under such conditions, a simple but reasonably accurate method of estimating body weight is very useful.

Based on heart girth measurements made on a number of steers exhibited at the Ogden and Salt Lake Junior Livestock shows, Professor James A. Bennett, Head, Department of Animal Husbandry, Utah State Agricultural College, developed the following ingenious formula for estimating steer weights:

Live Wt. = 1.04 [27.5758 (heart girth in inches)—1049.67].

Based on this formula, the calculated live weight values for steers grading Prime and Choice (new grades) and with heart girth measurements within the range of 63 to 80 inches is as shown in table VI.

TABLE VI

ESTIMATING STEER WEIGHTS FROM HEART GIRTH MEASUREMENTS

Heart girth inches	Calculated live weight pounds	Heart girth inches	Calculated live weight pounds
63	715	72	973
64	744	73	1002
65	773	74	1031
66	801	75	1060
67	830	76	1088
68	859	77	1117
69	887	78	1145
70	916	79	1174
71	945	80	1203

[1] Formulaes used in estimating weights of dairy cattle from heart girth measurements are not applicable to fat steers, beef animals being lighter than dairy animals of the same heart girth measurement.

Thus, if a steer (grading Prime or Choice) has a heart girth measurement of 63 inches, his calculated weight may be determined by (1) multiplying 27.5758 by 63, (2) subtracting 1049.67 from the product, and (3) multiplying the remainder by 1.04.

In taking heart girth measurement, it is important (1) that the steer be kept off feed and water for a minimum of 12 hours (an over-night shrink will be satisfactory and will avoid throwing the animal off feed), (2) that the animal stand with all four legs squarely under the body and with the head up in a normal position, and (3) that the tape be passed around the body just back of the shoulders at the smallest circumference and pulled up snugly.

TABLE VII

GESTATION TABLE

Date bred	Cow 283 days (date due)	Ewe 148 days (date due)	Sow 114 days (date due)	Mare 340 days (date due)
Jan. 1	Oct. 11	May 29	Apr. 25	Dec. 7
Jan. 6	Oct. 16	June 3	Apr. 30	Dec. 12
Jan. 11	Oct. 21	June 8	May 5	Dec. 17
Jan. 16	Oct. 26	June 13	May 10	Dec. 22
Jan. 21	Oct. 31	June 18	May 15	Dec. 27
Jan. 26	Nov. 5	June 23	May 20	Jan. 1
Jan. 31	Nov. 10	June 28	May 25	Jan. 6
Feb. 5	Nov. 15	July 3	May 30	Jan. 11
Feb. 10	Nov. 20	July 8	June 4	Jan. 16
Feb. 15	Nov. 25	July 13	June 9	Jan. 21
Feb. 20	Nov. 30	July 18	June 14	Jan. 26
Feb. 25	Dec. 5	July 23	June 19	Jan. 31
Mar. 2	Dec. 10	July 28	June 24	Feb. 5
Mar. 7	Dec. 15	Aug. 2	June 29	Feb. 10
Mar. 12	Dec. 20	Aug. 7	July 4	Feb. 15
Mar. 17	Dec. 25	Aug. 12	July 9	Feb. 20
Mar. 22	Dec. 30	Aug. 17	July 14	Feb. 25
Mar. 27	Jan. 4	Aug. 22	July 19	Mar. 2
Apr. 1	Jan. 9	Aug. 27	July 24	Mar. 7
Apr. 6	Jan. 14	Sept. 1	July 29	Mar. 12
Apr. 11	Jan. 19	Sept. 6	Aug. 3	Mar. 17
Apr. 16	Jan. 24	Sept. 11	Aug. 8	Mar. 22
Apr. 21	Jan. 29	Sept. 14	Aug. 13	Mar. 27
Apr. 26	Feb. 3	Sept. 21	Aug. 18	Apr. 1
May 1	Feb. 8	Sept. 26	Aug. 23	Apr. 6
May 6	Feb. 13	Oct. 1	Aug. 28	Apr. 11
May 11	Feb. 18	Oct. 6	Sept. 2	Apr. 16
May 16	Feb. 23	Oct. 11	Sept. 7	Apr. 21
May 21	Feb. 28	Oct. 16	Sept. 12	Apr. 26
May 26	Mar. 5	Oct. 21	Sept. 17	May 1
May 31	Mar. 10	Oct. 26	Sept. 22	May 6
June 5	Mar. 15	Oct. 31	Sept. 27	May 11
June 10	Mar. 20	Nov. 5	Oct. 2	May 16
June 15	Mar. 25	Nov. 10	Oct. 7	May 21
June 20	Mar. 30	Nov. 15	Oct. 12	May 26
June 25	Apr. 4	Nov. 20	Oct. 17	May 31
June 30	Apr. 9	Nov. 25	Oct. 22	June 5
July 5	Apr. 14	Nov. 30	Oct. 27	June 10
July 10	Apr. 19	Dec. 5	Nov. 1	June 15
July 15	Apr. 24	Dec. 10	Nov. 6	June 20
July 20	Apr. 29	Dec. 15	Nov. 11	June 25
July 25	May 4	Dec. 20	Nov. 16	June 30
July 30	May 9	Dec. 25	Nov. 21	July 5
Aug. 4	May 14	Dec. 30	Nov. 26	July 10
Aug. 9	May 19	Jan. 4	Nov. 31	July 15
Aug. 14	May 24	Jan. 9	Dec. 6	July 20
Aug. 19	May 29	Jan. 14	Dec. 11	July 25
Aug. 24	June 3	Jan. 19	Dec. 16	July 30
Aug. 29	June 8	Jan. 24	Dec. 21	Aug. 4
Sept. 3	June 13	Jan. 29	Dec. 26	Aug. 9
Sept. 8	June 18	Feb. 3	Dec. 31	Aug. 14
Sept. 13	June 23	Feb. 8	Jan. 5	Aug. 19
Sept. 18	June 28	Feb. 13	Jan. 10	Aug. 24
Sept. 23	July 3	Feb. 18	Jan. 15	Aug. 29
Sept. 28	July 8	Feb. 23	Jan. 20	Sept. 3
Oct. 3	July 13	Feb. 28	Jan. 25	Sept. 8
Oct. 8	July 18	Mar. 5	Jan. 30	Sept. 13
Oct. 13	July 23	Mar. 10	Feb. 4	Sept. 18
Oct. 18	July 28	Mar. 15	Feb. 9	Sept. 23
Oct. 23	Aug. 2	Mar. 20	Feb. 14	Sept. 28
Oct. 28	Aug. 7	Mar. 25	Feb. 19	Oct. 3
Nov. 2	Aug. 12	Mar. 30	Feb. 24	Oct. 8
Nov. 7	Aug. 17	Apr. 4	Mar. 1	Oct. 13
Nov. 12	Aug. 22	Apr. 9	Mar. 6	Oct. 18
Nov. 17	Aug. 27	Apr. 14	Mar. 11	Oct. 23
Nov. 22	Sept. 1	Apr. 19	Mar. 16	Oct. 28
Nov. 27	Sept. 6	Apr. 24	Mar. 21	Nov. 2
Dec. 2	Sept. 11	Apr. 29	Mar. 26	Nov. 7
Dec. 7	Sept. 16	May 4	Mar. 31	Nov. 12
Dec. 12	Sept. 21	May 9	Apr. 5	Nov. 17
Dec. 17	Sept. 26	May 14	Apr. 10	Nov. 22
Dec. 22	Oct. 1	May 19	Apr. 15	Nov. 27
Dec. 27	Oct. 6	May 24	Apr. 20	Dec. 2

ALL-TIME TOP SALES

Stockmen and students frequently like to refer to the great sales in the history of the many breeds. Presented herewith is a summary of some of the record sales, both for individual animals and consignments or herds.

TABLE VIII

ALL-TIME TOP INDIVIDUAL SALES

Breed	Year of Sale	Identity of animal	Sex	Price	Private treaty or auction	Seller	Purchaser
BEEF CATTLE							
Aberdeen-Angus	1946	Erianna B 6th	Cow	$25,000	Auction	J. Garrett Tolan, Pleasant Plains, Illinois	Vaughn Bros. Albion, Michigan
Aberdeen-Angus	1948	Prince Sunbeam 249	Bull	60,000	Private treaty	Sunbeam Farms, Miami, Oklahoma	Ellerslie Farm, Charlottesville, Virginia
Aberdeen-Angus	1950	Prince Eric of Sunbeam	Bull	100,000	Private treaty	L. L. O'Bryan, Lakewood Farms, Mukwonago, Wisconsin	Dr. and Mrs. Armand Hammer, Shadow Isle Farm, Red Bank, New Jersey
Hereford	1947	WHR Helmsman 89th, #4635085	Bull	61,000	Auction	Wyoming Hereford Ranch, Cheyenne, Wyoming	Hi-Wan Ranch, Evergreen, Colorado
Hereford	1947	T. T. Zato Heiress	Cow	35,000	Auction	Thornton Hereford Ranch, Gunnison, Colorado	Gerald Montgomery, Madera, California
Hereford	1949	Baca Duke 2d	Bull	65,000	Auction	Albert Noe Farms, Pulaski, Tennessee	A. H. Karpe, Greenfield Hereford Ranch, Bakersfield, California
Hereford	1950	Hillcrest Larry 4th #6,000,000	Bull	70,500	Auction	Hillcrest Farm Chester, West Virginia	Chino Farms, Church Hill, Maryland
Polled Hereford	1947	Alf Choice Domino 6	Bull	35,000	Auction	John M. Lewis & Sons Larned, Kansas	A. G. Rolfe, Spring Valley Farms, Poolesville, Maryland
Polled Hereford	1949	M. H. Supreme Beauty	Cow	10,700	Auction	Mousel and Haussler Holbrook, Nebraska	Mike Levis Livestock Co., Henderson, Colorado
Polled Hereford	1950	S. V. Letston Lady 4th, #361834	Cow	11,000	Auction	A. G. Rolfe, Poolesville, Maryland	C. C. Potter, Pottstown, Pennsylvania
Santa Gertrudis	1950	Lot No. 32	Bull	10,000	Auction	King Ranch, Kingsville, Texas	Edgar Brown, Orange, Texas
Shorthorn	1873	8th Duchess of Geneva	Cow	40,600	Auction	New York Mills, Utica, New York	R. P. Davies, England
Shorthorn	1946	Pittodrie Upright	Bull	61,335	Auction (Perth sale in Scotland)	Laidlaw Smith Pitcaple, Aberdeenshire, Scotland	Sni-A-Bar Farms Grain Valley, Missouri
SHEEP							
Hampshire	1917		Ram	1,600	Auction	Walnut Hall Farm, Donerail, Kentucky	D. F. Detweiler, Filer, Idaho
Hampshire	1918		Ram	1,700	Auction	Walnut Hall Farm, Donerail, Kentucky	D. F. Detweiler Filer, Idaho
Rambouillet	1918	"62"	Ram	6,200	Auction	J. H. Seely, Mt. Pleasant, Utah	C. N. Stillman Sigurd, Utah
Rambouillet	1918	Model	Ram	3,000	Auction	Butterfield Livestock Co., Weiser, Idaho	Bullard Bros., Woodland, California
Rambouillet	1921	Monarch	Ram	3,000	Auction	Butterfield Livestock Co., Weiser, Idaho	Bullard Bros., Woodland, California

All-Time Top Individual Sales—Continued

Breed	Year of Sale	Identity of animal	Sex	Price	Private treaty or auction	Seller	Purchaser
SHEEP—(continued)							
Rambouillet	1950		Ram	$2,500	Auction	Geo. L. Beal & Sons, Ephraim, Utah	The Pauly Ranch, Deer Lodge, Montana
Suffolk	1943		Ram	3,300	Auction	H. L. Finch & Sons, Soda Springs, Idaho	Glen N. Nelson, Eagle, Colorado
Suffolk	1947		Ram	2,500	Auction	Chas. Howland & Sons, Weiser, Idaho	Glen N. Nelson, Eagle, Colorado
Suffolk	1948		Ram	3,350	Auction	P. J. Rock & Son, Drumheller, Alberta, Canada	James Laidlaw & Sons, Inc., Muldoon, Idaho
SWINE							
Berkshire	1941	Pomeroy Falcon 2d	Boar	2,500	Auction	Pomeroy Farms, Barrington, Illinois	W. S. Ridgly, Decatur, Illinois
Chester White	1944	Portage Model	Boar	3,200	Auction	Portage Farms, Woodville, Ohio	Robert Naefke Clarion, Iowa
Chester White	1944	Lisle Ridgly-dale Model	Boar	3,400	Auction	Lisle Farms, Lisle, Illinois	Ridglydale Farms Decatur, Illinois
Duroc	1919	Jackson's Orion King #134009A	Boar	32,000	Private treaty	Ira Jackson, West Milton, Ohio	H. L. White, White's Duroc Farm, Columbia, Mississippi
Hampshire	1920	Cherokee Roller #66671	Boar	10,000	Private treaty	Chas. S. Boynton, Pleasant Plains, Illinois	Seth T. Hadley Danville, Indiana
Hampshire	1920	Venus #113072	Sow	4,000	Auction	F. R. Pierce, Mt. Vernon, South Dakota	Mrs. Jos. Kotrba Mitchell, South Dakota
Hampshire	1947	Comprest #338339	Boar	8,000	Private treaty	Parkfield Farm, Toluca, Illinois	C. E. Wilson, Oxford, Michigan
Hampshire	1948	Tru-Mold #364119	Boar	8,500	Private treaty	Fruehauf Farms, Cedar Rapids, Iowa	Chardon Farms, Grays Lake, Illinois
Hampshire	1949	Carmen Jane #904428	Sow	2,575	Auction	Mullady Farms, Elgin, Illinois	Model Farms, Mundelein, Illinois
Poland China	1919	The Clansman #92964	Boar	15,000	Private treaty	Silver Brook Farm, Muncie, Indiana	Wm. Wrigley, Jr. Lake Geneva, Wisconsin
Poland China	1919	Designer #93699	Boar	30,000	Private treaty	Wm. Ferguson, Scribner, Nebraska	D. C. Lonergan & Sons, Florence, Nebraska
Poland China	1920	Fashion Girl #219444	Sow	17,200	Auction	L. H. Glover, Grandview, Missouri	F. R. McDermand Kansas City, Missouri
Poland China	1920	Kramers Kind #219443	Sow	14,000	Private treaty	T. E. Thompson, Franklin, Indiana	Arlington Farms, Indianapolis, Indiana
HORSES							
American Saddle Horse	1947	Beau Fortune #19389	Stallion	50,000	Private treaty	Lloyd Teater and Harold B. Reesler of Skokie and Chicago, Illinois	Crebilly Farm, West Chester, Pennsylvania
Belgian	1917	Farceur	Stallion	47,500	Auction	Wm. Crownover, Hudson, Iowa	C. G. Good, Ogden, Iowa
Quarter Horse	1949	Geronimo	Stallion	20,000	Auction	J. Ralph Bell, Canoga Park, California	A. R. Levis, Henderson, Colorado
Shetland Pony	1950	Hillswicks Oracle	Stallion	4,300	Auction	Mrs. Volney Diltz Des Moines, Iowa	W. P. Atkinson, Oklahoma City, Oklahoma
Shetland Pony	1950	Dunrovin Larigo Flame	Mare	1,750	Auction	Gene Lowrey, Nebraska City, Nebraska	C. R. Donley, Anadarko, Oklahoma
Thorough-bred	1945	Stardust	Stallion	448,000	Private treaty	H.R.H. Aga Khan	Syndicate of English breeders

TABLE IX

ALL-TIME TOP CONSIGNMENT OR HERD SALES

Breed	Year of sale	Number of animals	Average price	Private treaty or auction	Seller
BEEF CATTLE					
Aberdeen-Angus	1946	46	5,614	Auction	Sunbeam Farms, Miami, Oklahoma
Hereford	1919	140	3,635	Auction	Warren T. McCray Kentland, Indiana
Hereford	1947	72	5,934	Auction	Wyoming Hereford Ranch, Cheyenne, Wyoming
Polled Herford	1946	50	2,588	Auction	Circle M. Ranch, Senatobia, Mississippi
Shorthorn	1873	109	$3,504	Auction	New York Mills, Utica, New York
Shorthorn	1919	39	5,140	Auction	Wm. Duthie of Collyne, Tarves, Aberdeenshire, Scotland
SHEEP					
Suffolk	1948	44 stud rams	585.90	Auction	National Ram Sale, Salt Lake City, Utah
SWINE					
Duroc	1920	50	$2,000	Auction	Ed. M. Kern Stanton, Nebraska
HORSES					
Thoroughbred	1947	436 yearlings	$6,827	Auction	Keeneland summer sales

BREED ASSOCIATIONS

Beef and Dual-Purpose Cattle Associations

American Aberdeen-Angus Breeders' Assn., Frank Richards, Secretary, 9 Dexter Park Avenue, Union Stock Yards, Chicago 9, Illinois.

American Brahman Breeders' Assn., Harry P. Gayden, Executive Secretary, 2711 South Main Street, Houston 2, Texas.

American Charbray Breeders' Assn., Miss Mildred Gloss, Secretary-Treasurer, Weslaco, Texas.

American Devon Cattle Club, Inc., Kenneth Hinshaw, Secretary-Treasurer, 704 Suffield St., Agawam, Massachusetts.

American Galloway Breeders' Assn. C. C. Wells, Secretary, 361 Southlawn, E. Lansing, Mich.

American Hereford Assn., Jack Turner, Secretary, 300 West 11th Street, Kansas City, Missouri.

American Milking Shorthorn Society, W. J. Hardy, Secretary, 313 S. Glenstone, Springfield, Missouri.

American Polled Hereford Breeders' Assn., Don W. Chittenden, Secretary, Mason Building, 1110 Grand Avenue, Kansas City 6, Missouri.

American Polled Shorthorn Society, Emily P. Krahn, Secretary, 7 Dexter Park Avenue, Union Stock Yards, Chicago 9, Illinois.

American Shorthorn Breeders' Assn., Clinton K. Tomson, Secretary, 7 Dexter Park Avenue, Union Stock Yards, Chicago 9, Illinois.

Pan-American Zebu Assn., Roy G. Martin, Secretary, Box 268, Cotulla, Texas.

Red Poll Cattle Club of America, F. A. Sloan, Secretary-Treasurer, 3275 Holdredge Street, Lincoln 3, Nebraska.

Sheep Associations

American Cheviot Sheep Society, Mrs. Katherine S. Turrell, Secretary, Route 1, Oneonta, New York.

American Corriedale Assn., Inc., Rollo E. Singleton, Secretary, 100 North Garth, Columbia, Missouri.

American Cotswold Record Assn., C. P. Harding, Secretary, Sigel, Illinois.

The American & Delaine-Merino Record Assn., D. S. Bell, Secretary, East Main Street, Wooster, Ohio.

American Hampshire Sheep Assn., Mrs. Helen Tyler Belote, Secretary, 72 Woodland Avenue, Detroit 2, Michigan.

American Oxford Down Record Assn., J. M. McHaffie, Secretary, Clayton, Indiana.

American Rambouillet Sheep Breeders' Assn., Jack B. Taylor, Secretary, San Angelo, Texas.

American Romney Breeders' Assn., H. A. Lindgren, Secretary, 200 Dairy Building, Corvallis, Oregon.

American Shropshire Registry Assn., Charles F. Osborn, Secretary, Lafayette, Indiana.

American Southdown Breeders' Assn., W. L. Henning, Secretary, 212 South Allen Street, State College, Pennsylvania.

American Suffolk Sheep Society, C. W. Hickman, Secretary, Moscow, Idaho.

Black Top and National Delaine-Merino Sheep Breeders' Assn., I. Y. Hamilton, Secretary, R.F.D. No. 4, McDonald, Pennsylvania.

Columbia Sheep Breeders' Assn. of America, Alma Esplin, Secretary, 112 North Main, Logan, Utah.

Continental Dorset Club, J. R. Henderson, Secretary, Hickory, Pennsylvania.

Karakul Fur Sheep Registry, Alta H. Robertson, Secretary, Friendship, Wisconsin.

Montadale Sheep Breeders' Assn., Inc., E. H. Mattingly, Secretary, 61 Angelica Street, St. Louis 7, Missouri.

National Lincoln Sheep Breeders' Assn., R. O. Shaffer, Secretary, Route No. 1, W. Milton, Ohio.

National Suffolk Sheep Assn., C. A. Williams, Secretary, Middleville, Michigan.

National Tunis Sheep Registry, Ralph E. Owen, Secretary, Fulton, New York.

Texas Delaine-Merino Record Assn., George H. Johanson, Secretary, Route 1, Brady, Texas.

Goat Associations

American Angora Goat Breeders' Assn., Mrs. Thos. L. Taylor, Secretary, Rocksprings, Texas.

American Goat Society, Inc., R. D. Weis, Secretary, Mena, Arkansas.

The American Milk Goat Record Assn., V. B. Bennett, Secretary, Ipswich, Massachusetts.

Swine Associations

American Berkshire Assn., Willard D. Brittin, Secretary, 601 W. Monroe St., Springfield, Illinois.

American Essex Swine Assn., Mrs. J. J. Lightall, Secretary-Treasurer, 1335 E. 2nd St., Muscatine, Iowa.

American Spotted Poland China Assn., Van G. Sutliff, Secretary, Moberly, Missouri.

American Yorkshire Club, Inc., E. Robert Shannon, Secretary, Wallace Building, Lafayette, Indiana.

Breeders' Chester White Record Assn., Lester W. Drennen, Secretary, 330 Royal Union Building, Des Moines 9, Iowa.

Breeders' Hereford Hog Record, Hugh J. Rukgaber, Secretary, Mt. Pleasant, Iowa.

Chester White Swine Record Assn., Levi P. Moore, Secretary, Rochester, Indiana.

Hampshire Swine Registry, R. L. Pemberton, Secretary, 915 Commercial National Bank Building, Peoria 2, Illinois.

Inbred Livestock Registry Assn., Dr. L. M. Winters, Secretary, University Farm, St. Paul 1, Minnesota.

Kentucky Red Berkshire Swine Record Assn., Hogan Teater, Secretary, Lancaster, Kentucky.

National Hereford Hog Record Assn., A. L. Hyzer, Secretary, Chariton, Iowa.

National Mule Foot Hog Record Assn., G. C. Kreglow, Secretary, DeGraff, Ohio.

National Spotted Poland China Record, Fred L. Obenchain, Secretary, 3153 Kenwood Avenue, Indianapolis 8, Indiana.

OIC Swine Breeders' Assn., Inc., Harry C. Miller, Secretary, Goshen, Indiana.

OIC Swine Assn., Mrs. Jane Roper, Secretary, Brookville, Ohio.

Poland China Record Assn., C. G. McCahan, Secretary, Galesburg, Illinois.

Tamworth Swine Assn., R. H. Waltz, Secretary, Hagerstown, Indiana.

United Duroc Record Assn., B. R. Evans, Secretary, 237-9 North Monroe, Peoria 3, Illinois.

Light Horse Associations

The American Albino Horse Club, Inc., Ruth E. White, Secretary, White Horse Ranch, Naper, Nebraska.

American Hackney Horse Society, Mrs. J. Macy Willets, Secretary, Room 1737-42 Broadway, New York, New York.

American Quarter Horse Assn., Raymond D. Hollingsworth, Secretary, 1405-b West Tenth Avenue, Amarillo, Texas.

American Saddle Horse Breeders' Assn., Chas. J. Cronan, Jr., Secretary, 929 South Fourth Street, Louisville 2, Kentucky.

American Shetland Pony Club, Wayne C. Kirk, Secretary, 518 East Dubail, South Bend, Indiana.

Appaloosa Horse Club, Inc., George B. Hatley, Secretary, Moscow, Idaho.

Arabian Horse Club of America, Frank Watt, Secretary, 111 West Monroe Street, Chicago 3, Illinois.

Cleveland Bay Assn. of America, A. Mackay Smith, Secretary, White Post, Virginia.

The Jockey Club (Thoroughbred), J. E. Davis, Secretary, 250 Park Avenue, New York 17, New York.

The Morgan Horse Club, Inc., F. B. Hills, Secretary, 90 Broad Street, New York 4, New York.

Morocco Spotted Horse Assn. of America, LeRoy Fritz, Secretary, Greenfield, Iowa.

National Quarter Horse Breeders' Assn. consolidated with American Quarter Horse Assn. March 10, 1950.

The Palomino Horse Association, Willard M. Beanland, Executive Secretary, Box 446, Reseda, California.

Palomino Horse Breeders of America, Dr. H. Arthur Zappe, Secretary, Box 79, Mineral Wells, Texas.

The Pinto Horse Society, George M. Glendenning, Secretary, Box 206, Concord, California.

Tennessee Walking Horse Breeders' Assn. of America, Miss Syd Houston, Secretary, Lewisburg, Tennessee.

United States Trotting Assn. (Standardbred), Ken McCarr, registrar, 1349 E. Broad St., Columbus 5, Ohio.

Welsh Pony Society of America, Frank H. Smith, Secretary, 409 West Engineering Building, University of Michigan, Ann Arbor, Michigan.

Draft Horse Associations

American Shire Horse Assn., E. F. Fox, Secretary, 319 East Fourth Street, Des Moines, Iowa.

American Suffolk Horse Assn., Inc., L. B. Westcott, Secretary, Clinton, New Jersey.

Belgian Draft Horse Corporation of America, Miss B. A. Schmalzried, Secretary, Wabash, Indiana.

Clydesdale Breeders' Assn. of the United States, Miss Margaret Coridan, Secretary, 840 Exchange Avenue, Union Stock Yards, Chicago 9, Illinois.

Percheron Horse Assn. of America, Mrs. Anne Brown, Secretary, 809 Exchange Avenue, Union Stock Yards, Chicago 9, Illinois.

Standard Jack & Jennet Registry of America, Mrs. N. E. Hineman, Secretary, Box 375, Garden City, Kansas.

BREED PUBLICATIONS

Many of the breed associations have their own official publications, while others use the columns of privately-owned publications devoted exclusively to their particular breed.

The livestock magazines publish news items and informative articles of special interest to stockmen. Also, many of them employ field representatives whose chief duty is to assist in the buying and selling of animals.

In the compilation of the list herewith presented, no attempt was made to list the general livestock magazines of which there are numerous outstanding ones.

Beef and Dual-Purpose Cattle Publications

American Hereford Journal, 600 Graphic Arts Bldg., Kansas City, Missouri.

The American Brahman, 504 M & M Bldg., Houston, Texas.

Brahman Breeder-Feeder, P. O. Box 2084, Houston 1, Texas.

Devon Cattle Quarterly, Agawam, Mass.

Polled Hereford World, 216 Falls Building, Memphis 3, Tennessee.

Milking Shorthorn Journal, 4122 S. Union Ave., Chicago 9, Ill.

Red Poll News, 3234 Starr St., Lincoln, Nebraska.

The Aberdeen-Angus Journal, Webster City, Iowa.

The Cattleman, Henry Biederman, Editor, Coliseum Bldg., Stockyards, Fort Worth, Texas.

The Polled Hereford Magazine, 127 S. Court, Montgomery, Alabama.

The Shorthorn World, 16 South Locust Street, Aurora, Illinois.

The Zebu Journal, 329 Texas Theatre Bldg., San Antonio 5, Texas.

Sheep Publications[1]

Sheep Breeder, 10 Watson Place, Columbia, Missouri.

The California Wool Grower, 151 Mission St., San Francisco 5, California.

The National Fur News, 444-17th Street, Denver, Colorado.

The National Wool Grower, 414 Pacific National Life Bldg., Salt Lake City 1, Utah.

The Sheep and Goat Raiser, Cactus Hotel Bldg., San Angelo, Texas.

The Sheepman Magazine, Box 68, Lexington, Kentucky.

Southwestern Sheep and Goat Raiser, Brady, Texas.

[1]Covers all breeds.

Goat Publications[1]

American Dairy Goat News, Richmond, Virginia.
Better Goat Keeping, Ipswich, Massachusetts.
Dairy Goat Bulletin, 210 East 5th Street, Charlotte, North Carolina.
Dairy Goat Journal, 8th & Broadway, Columbia, Missouri.
Sheep and Goat Raiser, Cactus Hotel Building, San Angelo, Texas.
The Bleat, Box 25, Victoria, British Columbia.
The Goat World, Roanoke, Virginia.

Swine Publications

American Hampshire Herdsman, Peoria, Illinois.
Berkshire News, Springfield, Illinois.
Chester White Journal, Rochester, Indiana.
Chester White World, Des Moines, Iowa.
Duroc News, Peoria, Illinois.
Hereford Swine Journal, Chariton, Iowa.
Hog Breeder, 313 Jefferson Bldg., Peoria 2, Ill.
OIC News, Goshen, Indiana.
Poland China Breeder, Box 79, Maryville, Missouri.
Poland China World, Des Moines, Iowa.
Swine World, Webster City, Iowa.
Tamworth Tips, Ames, Iowa. (News letter only).
The Spotted Poland China Bulletin, 3153 Kenwood Ave., Indianapolis, Indiana.
Yorkshire Journal, Valparaiso, Indiana.

Horse Publications

American Shetland Pony Journal, South Bend, Indiana.
Appaloosa Horse Club Stud Book, Moscow, Idaho.
Hoof Beats (U. S. Trotting), 1349 East Broad Street, Columbus 5, Mo.
Morocco Spotted Horse News, Greenfield, Iowa.
National Horseman, Louisville 2, Kentucky.
Palomino Horses, Mineral Wells, Texas.
Palomino Parade Year Book, Reseda, California.
Popular Horsemen, Hall Bldg., Locust at Second, Harrisburg, Pa.
Quarter Horse Journal, Box 2290, Amarillo, Texas.
Rider & Driver, 17 East 42nd Street, New York.
Saddle & Bridle, Suite 209, Hotel Chase, St. Louis 8, Missouri.
The Arabian Horse News, 205 Bell Bldg., Cheyenne, Wyo.
The Belgian Review, Wabash, Indiana.
The Bit and Spur, Bill Hagen, Editor, 123 North 25th St., P. O. Box 1458, Billings, Montana.
The Blood Horse, P. O. Box 1520, Lexington, Kentucky.
The Canter, Virginia Armstrong, Editor, Rt. 4, Box 403, Olympia, Wash.
The Harness Horse, Harrisburg, Pennsylvania.
The Horse Lover, San Francisco, California.
The Morgan Horse Magazine, Sumner Kean, Editor, Leominster, Massachusetts.
The Percheron News, 9 Dexter Park Avenue, Chicago 9, Illinois.
The Pinto Horse, Concord, California.
The Racing Calendar, 250 Park Ave., New York, N. Y.
The Tennessee Walking Horse, Lewisburg, Tennessee.
The Thoroughbred of California, 4824 Sunset Boulevard, Los Angeles 27, California.
The Thoroughbred Record, Lexington, Kentucky.
The Washington Horse, 8501 15th Ave., N.W., Seattle 7, Washington.
Vermont Horse & Bridle Trail Bulletin, Rutland, Vermont.
Western Horseman, Robert M. Denhardt, Editor, P. O. Box 1277, Colorado Springs, Colo.

[1]Covers all breeds.

STATE AGRICULTURAL EXPERIMENT STATIONS

A list of available bulletins, circulars, and other information regarding livestock can be obtained by writing to the Director of the Agricultural Experiment Station, or to the Director of Extension of the College of your state.

In United States

Alabama—
College Station: Auburn
Canebrake Station: Uniontown.
Tuskegee Station: Tuskegee.
Alaska—Sitka.
Arizona—Tucson.
Arkansas—Fayetteville.
California—Berkeley.
Colorado—Fort Collins.
Connecticut—
State Station: New Haven.
Storrs Stations: Storrs.
Delaware—Newark.
Florida—Gainesville.
Georgia—Experiment Coastal Station: Tifton.
Guam—Island of Guam.
Hawaii—Honolulu.
Idaho—Moscow.
Illinois—Urbana.
Indiana—Lafayette.
Iowa—Ames.
Kansas—Manhattan.
Kentucky—Lexington.
Louisiana—Baton Rouge.
Maine—Orono.
Maryland—College Park.
Massachusetts—Amherst.
Michigan—East Lansing.
Minnesota—University Farm, St. Paul.
Mississippi—State College.
Missouri—
College Station Columbia.
Fruit Station: Mountain Grove.
Poultry Station: Mountain Grove.
Montana—Bozeman.
Nebraska—Lincoln.
Nevada—Reno.
New Hampshire—Durham.
New Jersey—New Brunswick.
New Mexico—Agricultural College.
New York—
State Station: Geneva.
Cornell Station: Ithaca.
North Carolina—Raleigh.
North Dakota—Fargo.
Ohio—Wooster.
Oklahoma—Stillwater.
Oregon—Corvallis.
Pennsylvania—State College.
Puerto Rico—Mayaguez.
Rhode Island—Kingston.
South Carolina—Clemson.
South Dakota—Brookings.
Tennessee—Knoxville.
Texas—College Station.
Utah—Logan.
Vermont—Burlington.
Virginia—Blacksburg.
Washington—Pullman.
West Virginia—Morgantown.
Wisconsin—Madison.
Wyoming—Laramie.

In Canada

Alberta—Edmonton.
British Columbia—Vancouver.
Manitoba—Winnipeg.
Nova Scotia—Truro.
Ontario—Guelph.
Saskatchewan—Saskatoon.
Quebec—MacDonald College.
Dominion Department of Agriculture—Ottawa.

One should also write to the Superintendent of Documents, Washington, D. C., for lists of valuable bulletins and circulars.

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